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ANNALS
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Volume XXXVII DECEMBER, 1944 No. 4

DESCRIPTION OF THE MALE OF ERYTHRODIPLAX MACULOSA (HAGEN)

(Odonata: Libellulidae)

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Museu Nacional,
Rio de Janeiro, Brazil

Erythrodiplax maculosa (Hagen)

Nannophya maculosa Hagen, 1861, p. 187. *Ibid.*, 1863, p. 375. *Ibid.*, 1867, p. 90. *Ibid.*, 1874, p. 363. Karsch, 1890, pp. 245, 258. Needham, 1903, p. 722, fig. 17.
Nannothemis maculosa (Hagen). Brauer, 1868, p. 726. Hagen, 1875, p. 83. De Borre, 1889, p. 26. Kirby, 1889, p. 313. *Ibid.*, 1890, p. 45. Muttkowski, 1910, p. 147.
Erythrodiplax maculosa (Hagen). Muttkowski, 1910, p. 192. Ris, 1911, pp. 483, 526, fig. 316. *Ibid.*, 1919, p. 1161, fig. 671. Longfield, 1929, p. 130. Needham and Heywood, 1929, p. 214. Borror, 1942, pp. 119–120, figs. 44, 301, 377, Pl. XXXVII.
Diplacodes friedericella Förster, 1904, p. 2.
Diplacodina friedericella (Förster). Förster, 1904, p. 4.

Male: Head.—Labium and labrum black; anteclypeus nearly black; postclypeus yellow; frons metallic bluish black with a yellow spot on each side next to compound eye; vertex metallic bluish black; occiput black; rear of head black, with two small yellow spots on each side of occiput, and two yellow crescent-shaped or wedge-shaped areas on each side behind compound eye.

Thorax.—Prothorax with median lobe bluish black, somewhat pruinose; posterior lobe quadrate with distal angles rounded, the distal edge bearing a fringe of long hairs. Synthorax uniformly bluish black and lightly pruinose in adult; in teneral individuals dark brown, darker on dorsum and venter, with numerous irregular light areas. Legs uniformly black, the coxae somewhat lighter and pruinose. About ten spines on outer angle of hind femur, the proximal ones short, gradually increasing in length distally; penultimate spine about half as long as ultimate spine. Tarsal claw (fig. 2) with a small tooth situated at about two-thirds the length of the claw.

Wings.—Wings hyaline except for a small basal spot in front wing and a large basal spot in hind wing. Basal spot in front wing largely confined to cubital space, and extending about halfway to cubital crossvein or farther. Basal spot in hind wing brownish black, the

edges yellowish brown, usually with central portion of spot yellowish; this spot extends distally to the third or fourth antenodal, a cell beyond the triangle, and caudad to the outer angle and apex of the anal loop, and to the posterior margin of the wing. Stigma clear ashy yellow; membranule black or dark brown.

Venation.—Antenodals in front wing, 6½ (10%), 7 (10%), or 7½ (80%); postnodals in front wing, 4 (20%), 5 (10%), or 6 (70%); antenodals in hind wing, 6 (100%); postnodals in hind wing, 5 (90%), or 6 (10%); triangle in front wing free (100%), costal side broken in distal third (100%); triangle in hind wing free (95%) or crossed (5%); subtriangle in front wing 1-celled (40%) or 2-celled (60%); arculus equidistant between first and second antenodals (5%), or nearer second antenodal (95%); base of triangle in hind wing opposite arculus (100%); 1 bridge crossvein (100%); Mspl not developed (100%); Rspl poorly developed (100%); discoidal field of front wing with 1 (20%) or 2 (80%) cells bordering triangle, followed by 1(80%) or 2 (20%) cell rows, usually (90%) increasing to 3 rows at about level of nodus; anal loop with 10 (20%), 11 (20%), 12 (30%), 14 (20%), or 16 (10%) cells; intercalary cell in anal loop at anal angle of triangle present (50%) or absent (50%); 3–4 cell rows between anal loop and posterior margin of wing; Cu_1 in hind wing arising at anal angle of triangle (100%). Percentages based on 10♂.

Abdomen.—General color in adult black or nearly black, with a variable amount of bluish pruinescence, the pruinescence extending at most to segment 6; in teneral specimens there are wedge-shaped lateral spots on segments 3–6, with segments 1–2 largely yellowish. Superior anal appendages whitish yellow with dark tips; inferior anal appendage with anterior two-thirds of dorsal surface yellowish, the remainder of the dorsal side, and the ventral side, brownish black. For structure of anal appendages, and genitalia of segment 2, see figs. 4–9.

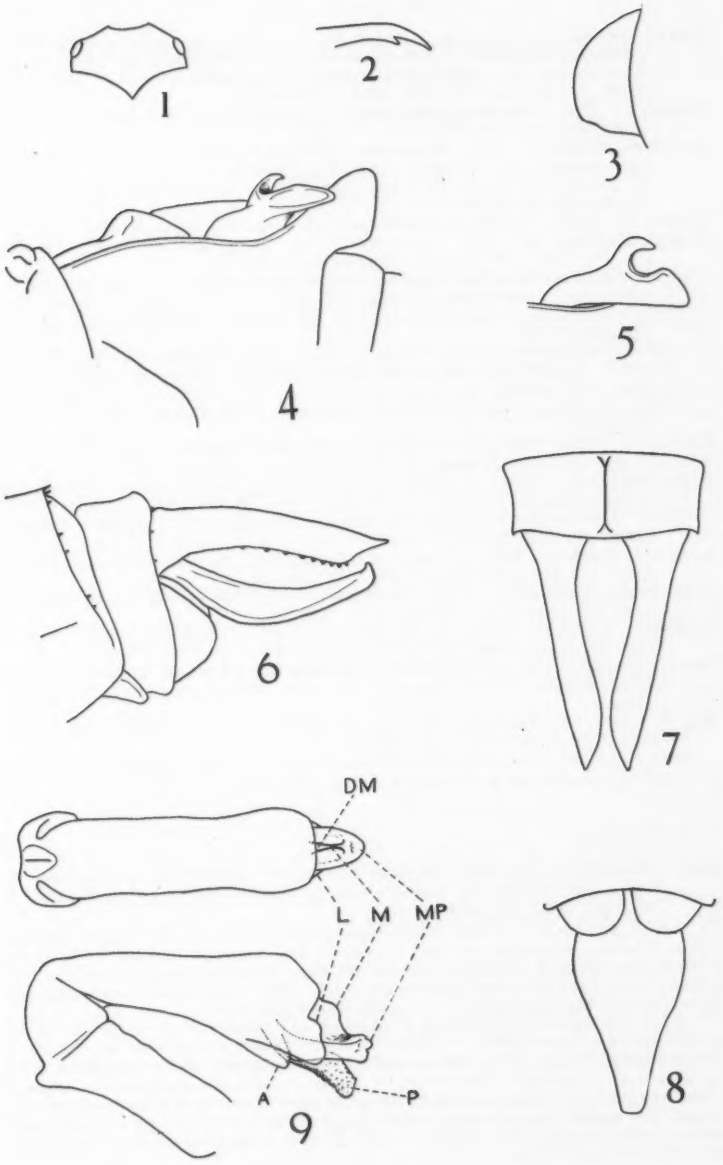
Measurements.—Front wing 17 x 5 mm., hind wing 16 x 5.5 mm.; abdomen 15 mm. (specimen from Pirassununga).

Material Examined.—9♂, Pirapora, Minas Geraes, Brazil, collected by J. Bailey, May 19, 1941; 1♂, Pirassununga, São Paulo, Brazil, collected by O. Schubart, January 17, 1940. The specimens from Pirapora are in the collection of the writer; the specimen from Pirassununga is No. 2573, Museu Nacional, Rio de Janeiro, Brazil.

EXPLANATION OF PLATE

Erythrodiplax maculosa (Hagen), male. FIGURE 1. Vertex, dorso-posterior view. 2. Tarsal claw. 3. Frons, lateral view. 4. Genitalia of segment 2, lateral view. 5. Hamule, antero-ventral view. 6. Anal appendages, lateral view. 7. Superior anal appendages, dorsal view. 8. Inferior anal appendage, ventral view. 9. Penis (upper figure, ventral view; lower figure, lateral view); *A*—apical lobe, *DM*—distal meatus of seminal duct, *L*—lateral lobe, *M*—medial lobe, *MP*—median process, *P*—posterior lobe.

Figures 1–8 were drawn with camera lucida; fig. 9 was drawn with projection apparatus from a specimen cleared in caustic potash and preserved in glycerine. Approximate magnifications: of figs. 1 and 3, 10×; of figs. 2 and 4–8, 28×; of fig. 9, 55×.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THE CADDIS FLIES, OR TRICHOPTERA, OF ILLINOIS, by HERBERT H. Ross. Bulletin of the Illinois Natural History Survey, Vol. 23, Art. 1, 326 pages, 961 figs., 1944.

This addition to the fine entomological monographs of the Illinois Natural History Survey maintains the high standards of previous publications. The two-column page seems a less attractive format than the older bulletins, but its proponents can, no doubt, find advantages in it. The typography is excellent and should contribute materially to the usefulness of the work.

The care expended in offering a thorough and taxonomically accurate survey of the order is noteworthy. Indeed, it seems rather exceptional in a work of limited faunal scope. With the comprehensive treatment of the included species and the many excellent illustrations of larvae, adults and anatomical details it should extend the value of the bulletin far beyond the state of Illinois and should make it a useful manual both to specialists in the group and to entomologists whose major interest lies elsewhere. Dr. Ross is to be congratulated on a truly monumental publication.—A. W. L.

ADDITIONAL NOTES ON ERYTHRODIPLAX MACULOSA (HAGEN)

(Odonata: Libellulidae)

DONALD J. BORROR,
Ohio State University,
Columbus, Ohio

At the time of the writer's revision of the genus *Erythrodiplax*[1] only three specimens of this species were known, the type male and a female in European collections, and a female (Förster's type of *Diplacodes friedericella*) in the Museum of Zoology at Ann Arbor, Michigan. Of these, only the latter specimen was available for study. Because of this lack of material, and particularly because no males of *maculosa* were studied, only a brief description could be given in the revision, and the status of the species in the genus could not be stated with certainty.

Through the kindness of Mr. N. Dias dos Santos of Rio de Janeiro, Brazil, the writer has had the privilege of examining a series of eight males and five females of this species, and with his excellent description (see preceding article) it is now possible to determine accurately the status of *maculosa* in the genus.

To Mr. Santos' statement the following might be added:

Venation (fig. 3).—A tabulation of the venational characters of the 14 specimens studied gives data very similar to those of Mr. Santos: Antenodals in front wing, 6½ (7%), 7 (11%), 7½ (78%), or 8½ (4%); postnodals in front wing, 4 (7%), 5 (78%), 6 (11%), or 7 (4%); antenodals in hind wing, 5 (7%), or 6 (93%); postnodals in hind wing, 5 (89%), or 6 (11%); triangles in front and hind wings free (100%); costal side of triangle in front wing broken (100%); 1 (19%), or 2 (71%) cells in subtriangle of front wing; in discoidal field of front wing, 1 (11%) or 2 (89%) cells bordering triangle, followed by 1 (96%) or 2 (4%) cell rows for one or two cells, increasing to 2 (4%), 3 (15%), 4 (77%), or 5 (4%) marginal cells; 1 (100%) cubital crossvein in hind wing; 1 (100%) bridge crossvein; Cu_1 in hind wing arising at anal angle of triangle (78%), or slightly separated from it (22%); 2 cells in anal loop of hind wing between bases of A_2 and Cu_2 (100%).

Penis (fig. 9, p. 000).—Penis small, terminal segment 0.83 mm. from proximal end to apex of lateral lobes; lateral lobes small, width at base (in lateral view) about one-third as wide as the penis at this point, somewhat quadrate with rounded angles, the dorsal angle somewhat prolonged distally; medial lobes lightly sclerotized, about

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Borror, Donald J. 1942. "A revision of the libelluline genus *Erythrodiplax* (Odonata)." Graduate School Studies, Contributions in Zoology and Entomology, No. 4, Biological Series, pp. xv+286, 41 plates, 1 text figure. Columbus, Ohio: The Ohio State University.

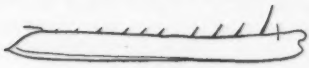
as large as lateral lobes, extending distally beyond apex of lateral lobes and fusing with median process; median process well developed and extending beyond apices of other lobes, somewhat sac-like at apex, its dorsal side with a pair of heavily sclerotized keels which extend proximad as far as apex of apical lobe; no internal lobes; a sac-like, erectile posterior lobe present, arising at the base of median process on dorsal side; apical lobe small, trough-shaped, extending distally as far as base of lateral lobes.

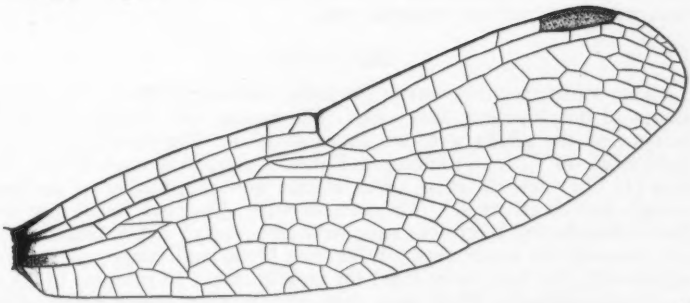
Measurements.—♂. Hind wing 16.5–17.5 mm. (average of 8♂, 16.75 mm.), abdomen 13.0–15.0 mm. (average of 7♂, 13.79 mm.), stigma of front wing 1.8–2.1 mm. (average of 8♂, 1.96 mm.) Ris (Cat. Coll. Selys, 1911, p. 527) gives the following measurements for the type ♂: hind wing 15.5 mm., abdomen 12.0 mm., stigma 1.5 mm. ♀. Hind wing 15.5–17.0 mm. (average of 6♀, 16.50 mm.), abdomen 13.0–13.5 mm. (average of 6♀, 13.25 mm.), stigma of front wing 1.8–2.1 mm. (average of 6♀, 1.93 mm.); Ris (*op. cit.*, 1919, p. 1162) gives the following measurements for a ♀ from Matto Grosso: hind wing 17.5 mm., abdomen 14.0 mm., stigma 2.0 mm.

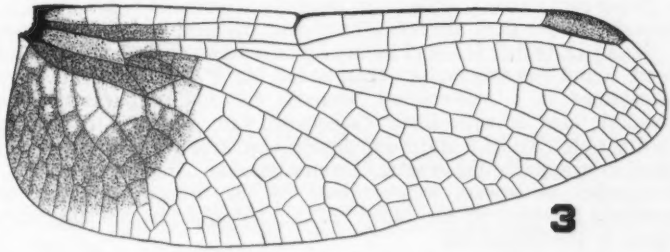
Material examined, 8♂ and 6♀. *Brazil:* Pirapora, Minas Geraes, 8♂ and 5♀, May, 1941 (J. Bailey, in coll. N. Santos). *Paraguay:* Costa Aquaray, 1♀, 1937 (Förster's type of *friedericella*, in coll. Mus. Zool., Ann Arbor, Mich.).

In the writer's revision of *Erythrodiplax* (*op. cit.*), *maculosa* was tentatively placed in the Basalis group next to *tenuis* Borror; this position is fully substantiated by the present series of specimens. The penis of *maculosa* is very similar to that of *tenuis;* in *maculosa* the lateral lobes are a little larger and have more rounded angles, and the median process is a little longer. Both species have the postclypeus yellowish and have the yellow lateral spots on the frons; they differ in the size of the basal spot in the hind wing, and in certain venational characters. In *tenuis* the basal spot in the hind wing extends only to the first antenodal, the cubital crossvein or a little beyond, and one or two cells caudad of the membranule (*cf. maculosa*, fig. 3). In *tenuis* the last antenodal is complete (usually incomplete in *maculosa*), and Cu_1 in the hind wing is broadly separated from the anal angle of the triangle (not so in *maculosa*).

In the writer's key to the species of *Erythrodiplax* (*op. cit.*) some specimens of *maculosa* would key out to *basalis* (Kirby) (couplet 29', p. 34). *E. basalis basalis* is usually larger than *maculosa* (hind wing of *basalis* 16.5–25.0 mm., of *maculosa* 16.0–17.5 mm.), the clypeus is black (the postclypeus is yellowish in *maculosa*), and the basal spot in the hind wing does not extend beyond the second antenodal and covers at most only the basal cells of the anal loop, and is bordered by an opal band 1–4 cells wide; in *maculosa* this spot is much larger (fig. 3), it lacks the bordering opal band, and the central portion of the spot is usually lighter in color. *E. b. basalis* occurs in the northern and northwestern part of South America (the Amazonian region of Brazil, Bolivia, Peru, Ecuador, and in Colombia, Venezuela, and the Guianas). *E. b. avittata* which occurs within the range of *maculosa*, has the face entirely bluish black, and is usually larger (hind wing 16.5–22.0 mm., average 20.5 mm.).







Erythrodiplax maculosa (Hagen). Figure 1. Head, lateral view. 2. Hind femur of male, showing spination on outer angle. 3. Wings of male. Figs. 1–2 drawn with camera lucida, magnification about 9×; fig. 3 drawn with projection apparatus, magnification about 5½×.

FAT INCLUSIONS IN BLOOD CELLS OF THE SOUTHERN ARMYWORM, PRODENIA ERIDANIA (CRAM.)

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Many of the blood cells, or hemocytes, of the southern armyworm normally contain glycogen inclusions (4). Whether they also normally contain inclusion of fat has not been reported. An investigation was begun on the existence of fat inclusions in southern armyworm hemocytes and of factors that might influence their occurrence, but it was necessary to discontinue this work before it was completed. The results that were obtained are reported here.

METHODS

The southern armyworm, *Prodenia eridania* (Cram.), in various stages of development, was used. The larvae were reared on collard leaves and the adults were fed sugar solution. The insects were heat-fixed at 55–60° C. for 5 minutes and blood smears were made in the usual way (4). In a few instances tissue smears were prepared after the blood smears had been made. The insects were dissected in 20 per cent formaldehyde and pieces of tissue were removed to slides, teased apart, and smeared on cover slips. When the blood and tissue smears were sufficiently dry, they were fixed for an additional 15 minutes in 20 per cent formaldehyde. They were then stained with sudan black as follows: 70 per cent alcohol, 30 seconds; alcoholic solution of sudan black B, 30 seconds; 70 per cent alcohol, 30 seconds; distilled water, 3 changes (2). Sudan II, Sudan III, and Sudan IV or Scharlach R were also used but were found less satisfactory than sudan black B. The smears were counterstained in a rose-colored, aqueous solution of pararosaniline hydrochloric acid or with Ehrlich's hematoxylin. Either a cover slip and a dry objective or a water-immersion objective without cover slip was used in examining the smears in water mounts.

A number of smears were stained by the Bauer technique to demonstrate glycogen in the blood cells and polysaccharide, probably glycogen, in the tissues (4).

Larvae were fed fat and carbohydrate in sandwiches. The latter consisted of disks of turnip or collard leaf between which were butter, olive oil, or a mixture of glucose and boiled cornstarch (4).

Blood-fat counts and indices were made in the same way as glycogen counts and indices (4). Four hundred blood cells selected at random were counted and classified as to whether they contained 0, 1, 2, 3, or more than 3 fat inclusions. This constitutes the fat count, having classes 0, 1, 2, 3, and 3<. The fat index consists of the total percentage of the cells that contain fat.

RESULTS

Fat counts and indices of blood cells were made at different periods in the development of normal *Prodenia eridania* reared in the usual way (3, 4). Only 1 count was made from a single insect. The periods of development and numbers of counts from each period were as follows: First instars, 10; third instars, 10; sixth instars, 10; prepupae, entering ground 2, slightly tapered 1, moderately tapered 8, greatly tapered 8; pupae, early first day 6, late first day 5, second to sixth days 10 each day, eighth day 2; adults, first day 4, second day 4, fourth day 2, fifth day 1. The manner in which the fat indices corresponding to these counts varied during the life of the insect is shown by the solid dots in figure 1. Only part of the sixth stadium is represented,

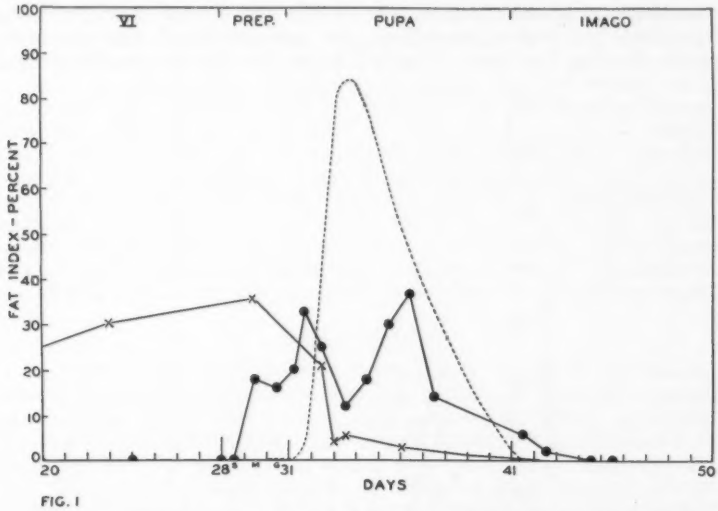

FIG. 1

FIGURE 1. Variation in percentage of hemocytes that contain fat inclusions during development of the southern armyworm, *Prodenia eridania* (Cram.). Fat index shown by solid dots, glycogen index (for comparison) by crosses, and plasma fat (nonquantitative estimate) by broken lines. Sixth stadium indicated by VI and days after hatching by arabic numerals. S, M, and G indicate slightly, moderately, and greatly tapered prepupae. Prep. means prepupa.

because no blood-cell fat was observed during the larval life of the normal insects reared on collard leaves. The broken-line curve is not based on quantitative counts. It represents only an opinion of how the fat in the plasma, exclusive of blood-cell fat, rises to a maximum and falls again to zero. This opinion is based on rough estimations of plasma fat in the smears from which the hemocyte-fat counts were made. The crosses represent the rise and fall of glycogen as indicated by the glycogen indices reported previously (4). Whereas blood-cell glycogen appeared shortly after hatching and rose gradually to a

maximum at about the middle of the prepupal stage, blood-cell fat did not appear until near the middle of the prepupal stage. The fat rose as the glycogen decreased. From the middle of the prepupal to beyond the middle of the pupal stage the index of blood-cell fat fluctuated about the 20–25 per cent level, then decreased. It disappeared in early imaginal life. Plasma fat appeared suddenly and rose very rapidly to a maximum at about the second or third day of pupal life. After that it fell quickly and disappeared at about the time of emergence of the adult.

The fat counts tended to have the same form as that already reported for glycogen counts (4) and, like the latter, are expressions of frequency distributions. This form is represented by $0 > 1 > 2 > 3 < 3+$, where the numbers represent the classes and the symbols their numerical relationship. About 12 per cent of the fat counts had the form $0 > 1 > 2 > 3 > 3+$, exceeding the percentage of the glycogen counts showing this form. Figure 2 shows how the fat count varies as

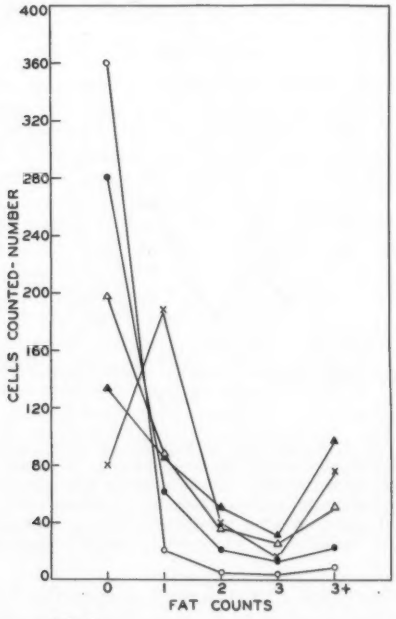

FIG. 2

FIGURE 2. Variation in hemocyte-fat counts with change in fat index. Ordinate shows number of cells counted; abscissa, the classes of the count, based on whether a hemocyte contains 0, 1, 2, 3, or more than 3 fat inclusions. An average of those counts whose fat indices vary from 0–20 per cent (mean of 10.0 per cent) are shown by open circles, from 20–40 per cent (mean of 28.8 per cent) by solid dots, from 40–60 per cent (mean of 50.4 per cent) by open triangles. Single counts are shown by solid triangles (index of 66.5 per cent and crosses (index of 80.0 per cent).

the fat index rises. This relationship is the same as that between glycogen counts and indices. The fat counts having indices of 66.50 and 80.00 are single counts, the others averages; this probably explains the crossing of the curves.

A few sixth instars were fed turnip-leaf sandwiches that contained butter or olive oil. Fat inclusions began to appear in the hemocytes in about 45 minutes. Considerable fat was observed at 1.5 and 3.0 hours after feeding. Too few experiments were done to indicate any differences in the use of butter or olive oil Ingestion of each was followed by the appearance of blood-cell fat. One or two droplets of fat appeared occasionally in the plasma.

When fifth instars were fed for about 24 hours on sandwiches containing glucose and cornstarch, the ingestion of the excess carbohydrate did not cause fat to appear in the hemocytes, although duplicate smears stained by the Bauer method indicated that glycogen had increased considerably.

In tissue smears from normal sixth instars, material stained with sudan black B, considered to be fat, was found in the following tissues: Fat body, Malpighian tube, nerve cord and ganglia, salivary gland, gonad, body muscles, and midgut epithelium. It was found less definitely in the pericardial cells. Its presence in heart-muscle and alary-muscle fibers was questionable. It was not found in trachea or peritracheal tissue. In the normal larvae reared on collard leaves the fat in the epithelial cells of the gut consisted of fine granules. After ingestion of sandwiches containing butter or olive oil, the gut cells became loaded with large fat inclusions, which were stained with the sudan black.

DISCUSSION

Cellular details could not be distinguished as well in the smears fixed in formaldehyde, stained with sudan black and mounted in water, as in smears stained for glycogen and mounted in balsam or clarite. The fat counts and indices consequently involved a greater error of counting than did the glycogen counts and indices previously reported (4). This might account in part for more fat than glycogen counts having the form. $0 > 1 > 2 > 3 > 3+$. Whether, as in the glycogen counts, this form reflects the lack of fat inclusions in certain kinds of blood cells was not determined.

Although blood-cell glycogen rose gradually during larval development, cellular fat detectable by this histochemical method normally did not appear until the prepupal stage. During the prepupal stage the total glycogen content of the insect (1), as well as its blood-cell glycogen, rose to a maximum at about the time of pupation. In the latter half of the prepupal stage, when total glycogen and probably blood-cell glycogen were on the increase, blood-cell fat rose also. It is apparent that metamorphosis ultimately involves a decline of blood-cell glycogen and a rise of blood-cell fat, but a connection between the two changes is not shown by these data. It does not follow necessarily that the blood-cell fat was formed by a transformation of glycogen, although such might actually have occurred. The failure to produce blood-cell fat by feeding the larvae excess carbohydrate in the few experiments

carried out would seem to argue against the origin of blood-cell fat from blood sugar and presumably from glycogen by way of blood sugar. The production of fat in hemocytes by feeding fats to the larvae suggests a lipoid origin of the fat that appeared in the hemocytes during metamorphosis, possibly from the lipoids of the fat body. It is possible that some of the fat droplets liberated by the adipose tissue during metamorphosis might have been phagocytized by hemocytes (3) but most of the fat inclusions in the blood cells are not considered to have originated in this way.

The feeding of excess fat to sixth instars has shown that the blood cells of these larvae have the capacity to contain fat inclusions but ordinarily are not called upon to use it.

The plasma fat appeared as droplets floating free in the plasma and as inclusions in the tissue debris that appears in the circulating blood during metamorphosis. The tissue debris is considered to consist almost entirely of liberated fat body cells, and the free fat droplets probably originated from the adipose cells (3).

CONCLUSIONS

The hemocytes of southern armyworm larvae, reared on only collard leaves, contain practically no fat inclusions before the insect reaches the prepupal stage. Fat inclusions first appear in the prepupal stage, are found throughout the pupal stage, and practically disappear in the first part of the imaginal stage. In general, fat appears and continues to be found in the hemocytes as glycogen disappears from them. Droplets of fat, as well as liberated adipose cells, are present in the plasma during metamorphosis.

The hemocytes of sixth or earlier instars can contain fat inclusions if the larvae ingest sufficient fat (butter, olive oil) in their diet.

Like glycogen counts, hemocyte fat counts represent frequency distributions. They tend to have the form $0 > 1 > 2 > 3 < 3+$ and to exhibit a maximum in a higher class as the fat index increases.

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NUTRITIONAL REQUIREMENTS OF CAMPONOTUS ANTS[1]

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It has been shown that the amount of food received by colonies of *Camponotus* influences imaginal stature among the workers produced (Smith, F. 1942). The following experiments were performed to see if the quality of the food received by *Camponotus* colonies would influence the size of the workers produced. *Camponotus herculeanus* subspecies *pennsylvanicus* DeGeer is probably both aphidicolous and entomophagous because the workers are commonly observed visiting aphids on the branches and leaves of trees. They will also readily attack and devour insect larvae that are given to them, whether in the laboratory or in the runways of their nests out-of-doors.

It was first necessary to find a complete basal ration whose constituents might be altered in a known way. For this purpose recent literature on insect nutrition was searched in order to find records of synthetic diets which could be used in the experiments.

The basal diet prepared for the experiments with *C. pennsylvanicus* contained the following materials in the proportions shown: casein, 1.8 gms.; sucrose, 6.6 gms.; fat, 0.2 gm.; linoleic acid, 0.05 gm.; cholesterin, 0.05 gm.; salt mixture,[3] 0.3 gm. This basal diet was then supplemented with 0.9 gm. of Brewers' yeast. In preparing the food it was found best to pulverize the granulated sugar in a mortar and then add the other materials, being careful thoroughly to mix all the ingredients. The food was stored in a refrigerator until it was used.

Camponotus pennsylvanicus colonies were brought to the laboratory where they were placed in Fielde nests arranged as will be described later. All experiments were carried on in a warm room (25°–30° C.) and each nest received as nearly identical treatment as possible. There was constantly present in the nests an abundance of both food and distilled water. Each nest was examined every second day from the start of the experiment until its termination. At every inspection pupae, if present, were removed, and worker eggs were destroyed when they were found. Care had to be taken to remove every trace of old food or other refuse from the nest so that the fresh food would not become contaminated. Pupae were weighed immediately on removing them from the nest and their weight as well as the date of their appearance was recorded.

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[1]This study is condensed from a portion of the dissertation presented to the Faculty of Harvard University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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[3]U. S. Pharmacopoeia, 1939 (Supplement), p. 132.

The method used in feeding the ants was simple. A drop of distilled water was placed in the center of a one-inch square of heavily waxed paper. To this drop of water was added a small amount of the food. The water and food were then mixed with a glass rod to form a thin paste. This square of paper containing the food was then placed in the nest. At the next inspection of the nest the square of waxed paper was removed and a fresh one, containing food, was added. A small cotton swab moistened with 95% alcohol was used to clean the floor of the nest.

THE INFLUENCE OF VARYING AMOUNTS OF DIETARY PROTEIN UPON CAMPONOTUS PROGENY

The following experiment sought to discover whether the stature of *Camponotus* progeny might be altered by changes in the amount of protein in the food received by the colony. Since it is impossible to control the amount of food the ants eat, except within very wide limits, it turned out that a decrease in one of the main components in the basal ration fed to the ants resulted in an increase in all the other components. Thus, if the amount of casein were halved in the preparation of the food, there would be a proportional increase in the other materials. This meant that instead of dealing with the one variable, i. e., the amount of casein, the experimenter was confronted with a number of variables represented by the amount of each substance in the synthetic diet. Nevertheless it was felt that adequate amounts of each constituent were present in the diet even where the dilution was greatest.

Two large colonies of *C. pennsylvanicus* were collected with their larvae. Into each of fifteen Fielde nests there were placed 30 nurse ants selected at random from the parent colonies, together with 95 larvae. The distribution of the ants and their larvae is made clear from an examination of Table I. The feeding of all nests was begun at the same time and was continued for 68 days.

Five lots of basal diets lacking in casein were now prepared and placed in vials numbered 1 to 5. To these vials there was added technical casein in such a way that the first contained the least amount of casein and the fifth vial contained the greatest amount. The amounts of casein used were as follows: 0.2 gm., 0.9 gm., 1.8 gm., 3.6 gm., 5.4 gm. These diets were then fed to the ants and the results are shown in Table I.

Individual larvae were not weighed to obtain the average weight per larva at the start of the experiment. The 95 larvae were weighed en masse and the average weight per larva was calculated. While this method is only approximate in its results it does provide a basis for the comparison of larval size among the experimental nests.

The number of pupae produced is seen from Table I to vary considerably, and this variation is correlated with the quantity of dietary casein in only one instance. Where 5.4 grams of casein was used in the diet, the numbers of pupae produced were markedly less than was found true in those nests receiving a smaller amount of casein in their food. This reduction in numbers of pupae is interpreted to be due to an inadequacy in the diet which contained 5.4 grams of casein, and indi-

cates that a rich protein diet is not a satisfactory one for *C. pennsylvanicus* colonies.

From the relative weights of the pupae produced in the nests it is clear from Table I, that a protein-rich diet is an unsatisfactory one for *Camponotus* colonies. With a diet containing 5.4 grams of casein the average pupal weights were always less than when a smaller amount of casein was used. Unfortunately a graded series of pupal weights corresponding to the amounts of casein in the food, was not obtained in this experiment. This is thought to be due to factors other than dietary ones, which were not under control during the course of the experiment.

TABLE I

DATA TO SHOW THE INFLUENCE OF VARYING AMOUNTS OF DIETARY PROTEIN UPON *Camponotus* PROGENY

Colony	Nest Number	Casein Content of Diet in gm.	Average Weight Per Larva at Start in mgm.	Number of Pupae Produced	Average Weight per Pupa in mgm.	Average Head Width of Progeny in Ocular Units	Standard Deviation of Head Width
K	1	0.2 gm.	0.42 mgm.	59	8.03 mgm.	42.7	8.27
	2	"	0.42	52	7.53	44.2	7.88
L	3	"	0.28	17	16.62	40.7	....
K	4	0.9 gm.	0.48	46	6.91	44.4	7.40
	5	"	0.43	48	7.66	41.2	8.48
L	6	"	0.35	24	16.70	46.7	8.56
K	7	1.8 gm.	0.38	59	7.94	44.0	5.50
	8	"	0.50	48	8.53	44.4	9.40
L	9	"	0.37	21	16.74	49.0	8.34
K	10	3.6 gm.	0.44	55	8.49	45.1	8.98
	11	"	0.42	58	7.53	43.3	7.78
L	12	"	0.26	15	19.2	44.0	....
K	13	5.4 gm.	0.40	20	6.6	39.5	3.50
	14	"	0.58	17	7.0	44.6	10.7
L	15	"	0.29	10	11.5	46.2	6.11

Comparison of the average pupal weights with the average larval weights shown in Table I, indicates that the pupal weight is correlated with the weight of the larva at the beginning of the experiment. This correlation was not constant, however, as can be seen by comparing the weights of the larvae and pupae produced in nests 1, 2, 4 and 5. There is a correlation seen elsewhere in Table I, between the larval weights which suggests that determination of imaginal size in *Camponotus* must occur at an early stage in the life history of these ants, but that, despite this fact, adult stature can be altered by conditions which exist between the time that imaginal size is determined and the time of pupation. Other than this nothing is known about the time of size determination among incompletely polymorphic ants such as *Camponotus*.

Average head widths of the ants produced in the experiment are seen from Table I to vary considerably. There is shown however, a tendency toward the production of individuals of smaller stature where a protein-rich diet was fed to the nurse ants.

Calculations upon the range of variation in stature of the ants produced in these nests were made, and the standard deviation in Table I expresses this range of variation for the imagines produced in each nest. The standard deviation was shown to be a useful index of nutritional conditions in colonies which were under-fed, Smith op. cit. The standard deviation of the workers produced in nests 3 and 12 could not be calculated because the progeny consisted largely of males in these two nests. It is evident from Table I that in two nests at least (13 and 15), a protein-rich diet resulted in a marked reduction of the variation among the imagines produced. In this respect the ants produced in nest 14 were at considerable variance from those produced in the other nests.

A diet, rich in proteins, has a deleterious effect upon the progeny in colonies of *Camponotus pennsylvanicus*. This harmful effect is noted in several ways: fewer of the larvae attain to pupation in the colony; the average pupal weights are less; and the standard deviation of the head widths and hence the stature of the imagines produced, is less when a protein-rich diet is supplied to the nurse ants.

THE EFFECT OF A SALT-FREE FOOD UPON THE PROGENY OF CAMPONOTUS COLONIES

The following experiment was undertaken to discover whether the salt mixture employed was of value as a nutritional component in the synthetic diet fed to colonies of *C. pennsylvanicus*. The basal diet already described was fed to the ants in the control nests, and a new diet was prepared in the same way as the basal diet except that no salt mixture was added to it.

Colonies K and L, used in the previous experiment, again supplied larvae and nurse ants for use in this experiment. 30 ants, selected at random from the parent colonies, were placed in each Fielde nest. The ants were given 95 larvae, weighed as before. Pupae were removed and weighed immediately upon removal from the nest. The experiment was carried on for 68 days, and all conditions were kept as nearly uniform as possible for each nest.

Table II summarizes the results obtained in this experiment and it is seen that nests 1, 2 and 3 are the controls for nests 4, 5 and 6, respectively.

The larval weights at the start of the experiment are shown in Table II. There is seen to be a large variation in the average weights of the larvae used.

A nearly equal number of pupae was produced in the nests, and it is clear from Table II that the removal of the salt from the diet had no appreciable influence upon the numbers of pupae produced in the nests.

Removal of the salt mixture from the diet fed to the ants in nests 4 and 5, resulted in pupae whose average weight was greater than the average weight of pupae produced in the control nests 1 and 2. The apparently anomalous pupal weights in nests 3 and 6 may be explained by the fact that a large percentage of the pupae produced were males.

Comparison of the average head widths of the imagines produced in the experiment under consideration, reveals that individuals of larger stature result in every instance where the salt mixture was removed from the diet fed to the nurse ants.

Finally, from Table II, it may be seen that the standard deviation of the head widths of the progeny in nests 4, 5 and 6 was greater than was found to be true in the control nests. Thus, the salt mixture employed in the basal ration evidently inhibited variation among the progeny.

The findings noted above lead to the conclusion that the salt mixture inhibited in some way the normal growth of the developing larvae. It is difficult to explain this negative reaction to a salt mixture which is known to be an adequate one for vertebrate animals (see McCollum, E. V. 1939, chapters 7–10). Unfortunately, little is known of insect requirements for mineral nutrients (Trager, Wm., 1941) and from the results obtained in this experiment it is seen that some ion or group of

TABLE II

DATA TO SHOW THE EFFECT UPON THE PROGENY OF TWO COLONIES OF *C. pennsylvanicus* WHOSE NURSES WERE FED WITH SALT-FREE DIETS

Colony	Nest Number	Diet	Average Weight Per Larva at Start in mgm.	Number of Pupae Produced	Average Weight Per Pupa in mgm.	Average Head Width of Progeny in Ocular Units	Standard Deviation of Head Widths
K	1	Basal	0.38 mgm.	59	7.94 mgm.	44.0	5.50
	2	"	0.50	48	8.53	44.4	9.42
L	3	"	0.37	21	16.74	49.0	8.34
K	4	Salt-Free	0.84	49	9.92	50.82	10.41
	5	"	0.40	47	11.08	49.32	11.84
L	6	"	0.32	26	16.09	51.47	10.77

ions provided by the salt mixture included in the basal diet, were harmful to the developing larvae. This harmful effect can hardly be attributed to the amount of the salt mixture included because it made up only 3% of the diet. This amount is less than the amount of a similar salt mixture other experimenters have used in insect nutrition work (Frobrich, G., 1939).

An experiment has been done which demonstrates the harmful character of a salt mixture, used to supply the mineral nutrients in a synthetic diet fed to colonies of *C. pennsylvanicus*. This salt mixture is known to be adequate for vertebrate animals, yet it was found to contain noxious substances when fed to the ants. More investigation is necessary upon insect requirements for mineral nutrients before it is possible to explain the harmful effect of the salt mixture.

Clearly, the amounts of such mineral nutrients required by colonies of *Camponotus* must be very minute, since the minerals present as impurities in a salt-free diet sufficed to produce good growth among the progeny of these ants.

THE EFFECT OF A FAT-FREE DIET UPON THE PROGENY OF CAMPONOTUS COLONIES

The experiment about to be described sought to discover whether fats played an important role in the nutrition of any colonies. Two colonies, M and N were collected with their larvae and brought to the laboratory. 30 nurse ants were selected at random and placed in each of the Fielde nests as indicated in Table III. 95 larvae weighed as before, were given to the nurse ants already arranged in the nests.

TABLE III

DATA TO SHOW THE EFFECT UPON PROGENY OF TWO COLONIES OF *C. pennsylvanicus* FED A FAT-FREE DIET

Colony	Nest Number	Diet	Average Weight Per Larva at Start in mgm.	Number of Pupae Produced	Average Weight Per Pupa in mgm.	Average Head Width of Progeny in Ocular Units	Standard Deviation of Head Widths
M	1	Basal	0.37 mgm.	27	9.14 mgm.	45.31	4.56
	2	"	0.38	34	8.91	44.34	5.24
N	3	"	0.70	42	9.80	46.1	10.74
M	4	Fat-free	0.43	41	9.71	45.23	5.08
	5	"	0.41	44	9.86	46.40	4.48
N	6	"	0.34	45	8.5	43.28	10.81

The ants in nests 1, 2 and 3 were fed the basal diet described above, and these nests served as controls for nests 4, 5 and 6 respectively. The ants in the latter nests were fed a diet similar to the basal diet except that it was rendered fat-free in the following way: the technical casein and yeast were separately washed 7 times with anhydrous ethyl-ether. The latter substance was selected because it was felt to be freer of impurities which might be left in the food and prove noxious to the ants. After this treatment both the ether-washed yeast and the ether-washed casein were then weighed in the amounts used in the basal diet, and these were added to the other ingredients of the diet. None of the fats used in the basal diet were added to this fat-free diet.

Inspection of Table III shows that the absence of fat from the diet of the nurse ants did not appreciably affect the progeny. The data shown in Table II indicates that colonies of *C. pennsylvanicus* are not sensitive to the absence of fat from an otherwise fully complemented diet. This finding is not surprising when we consider the meager fat requirements of insects in general (Melampy, R. M., 1937 and Trager, Wm., 1941). It is possible that a small amount of fat may still have remained in the casein and in the yeast even after numerous ether-washings. If such was the case, however, there must have been a very minute amount of fat remaining, and it is therefore evident that only minute amounts of fat, if any, are required by *Camponotus* colonies in rearing their brood.

THE EFFECT OF A VITAMIN-FREE DIET UPON THE PROGENY OF CAMPONOTUS COLONIES

It was thought to be important to discover whether the absence of vitamins from the diet of *Camponotus* colonies might influence in any way the progeny which would result from colonies fed such a diet. For this purpose colony M was again used as a source for the nurse ants and larvae. 30 nurses were selected at random and placed in Fielde nests. 95 larvae were weighed as before and given to the ants.

A vitamin-free diet, similar to the basal diet was prepared by replacing the technical casein of the basal diet with vitamin-free casein.[4] No yeast was used in the vitamin-free diet thus prepared. The control nests were fed with the basal ration prepared as has been described above. It was assumed that the quality of the vitamin-free casein was not impaired by the removal of the vitamins.

The ants were given an abundance of food and distilled water and the experiment was continued for 68 days. Pupae were removed on their appearance in the nest and weighed immediately.

Table IV summarizes the results obtained from this treatment of a single colony of *Camponotus pennsylvanicus*.

TABLE IV

DATA TO SHOW THE EFFECT UPON THE PROGENY OF A *C. pennsylvanicus* COLONY FED A VITAMIN-FREE DIET

Nest Number	Diet	Average Weight Per Larva at Start in mgm.	Number of Pupae Produced	Average Weight Per in mgm. Pupa	Average Head Widths of Progeny in Ocular Units	Standard Deviation of Head Widths
1	Basal	0.37 mgm.	27	9.14 mgm.	45.31	4.56
2	"	0.38	34	8.91	44.34	5.24
3	Vitamin-free	0.40	18	7.35	41.58	4.22
4	"	0.38	21	7.80	42.61	3.56

From Table IV it may be seen that a vitamin-free diet proved to have a number of harmful effects upon the progeny of the colony. The pupae produced were fewer in number and were not as heavy, on the average, as were the pupae produced in nests whose nurses were supplied with a diet containing a full complement of vitamins. The average head width and hence the stature of the imagines was found to be greater when the diet was enriched with yeast. The standard deviation of the head widths was found also to be less in nests 3 and 4, whose nurses had been fed a vitamin-free diet.

It is clear from this experiment that the normal growth of the progeny in colonies of *C. pennsylvanicus* requires at least those vitamins which are supplied by Brewers' yeast. That the ants did as well as they

[4]Supplied through the courtesy of the Borden Company Laboratories, Bainbridge, N. Y.

did when fed a vitamin-free diet, must be attributed to the activity of the rich bacterial flora which is found in the gut both of the larvae and adult ants (Lilienstern, M., 1932). This bacterial flora must be held responsible for the elaboration of the vitamins necessary for the growth of the larvae in nests 3 and 4.

SUMMARY

1. Experiments have been done which show that qualitative differences in the food given to colonies of *Camponotus herculeanus* subsp. *pennsylvanicus* DeGeer influence to a greater or less degree the stature, weight and number of progeny the colonies will produce.

2. Diets rich in protein have a deleterious effect upon the progeny.

3. A salt mixture which is known to be adequate for vertebrate animals is found to be harmful to ants.

4. The absence of fat from the diet of *Camponotus* colonies does not influence their progeny.

5. *Camponotus* colonies are sensitive to a vitamin deficient diet because the imagines produced are smaller in stature and fewer in number when the colonies are fed such a diet. It is concluded that the bacterial flora known to be present in the gut of the nurse ants and their larvae elaborates vitamins in sufficient quantity to permit larval development to proceed, albeit somewhat abnormally.

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INSECTS OF PORTO RICO AND THE VIRGIN ISLANDS, RHOPALOCERA OR BUTTERFLIES, by WILLIAM PHILLIPS COMSTOCK. New York Academy of Sciences, Scientific Survey of Porto Rico and the Virgin Islands, Vol. XII, Part 4, pp. 421–622, 29 figs., 12 plates, 1944. Price $2.00.

The butterflies and skippers of the West Indies continue to be a tantalizing group because of the extensive insular variation. Comstock's thorough survey should be of great value in resolving the taxonomic problems of lepidopterists whose resources are not extensive. The publication does not key the genera and species, nor does it present descriptions of all species and subspecific units, but it abounds in critical analyses of difficult relationships and in descriptions of details, and includes many figures of neuration, a few of genitalia and excellent half-tone plates of the wings of many species. The typography and paper are excellent. Recognizing with the writer that the gaps in our knowledge of the insect fauna are staggering, we must feel that he will realize his hope of providing a stimulus to future workers on this fauna, and more than that, a contribution that will be a very real help.—A. W. L.

THE RELATION OF HIND TIBIAE AND SENSORIA TO INTERMEDIACY IN PARTHENOGENETIC APHIDS

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Intergrades of various kinds as intersexes, intermediates and mosaics usually are considered abnormal individuals that occur sporadically as a result of an upset in the normal developmental pattern. To consider normal, regularly occurring animal forms intermediate or mosaic in the same sense as the abnormal forms are intermediate or mosaic may be incorrect, yet the winged and the wingless parthenogenetic female aphids may be so interpreted; and if this interpretation is the correct one it should result in a better understanding of the mechanism of aphid type production. It is the purpose of this paper to report the results of an investigation into the question of whether or not the normal parthenogenetic female aphids are in reality intermediate between males and gamic females.

The characters by means of which aphid types are distinguished can be classified into two groups, male and gamic female. Some of the characters associated with maleness are wings, wing muscles, ocelli, many antennal sensoria, thin hind tibiae and a male reproductive system. Gamic female characters include absence of wings, wing muscles, and ocelli, few antennal sensoria, hind tibia that are swollen, darkly colored and covered with hundreds of sensoria and a female reproductive system. Obviously these characters are found in either males or gamic females, but also some of them are found in the parthenogenetic females. For instance wings, wing muscles and ocelli are found not only in the males but also in winged parthenogenetic females. Likewise the absence of wings, wing muscles and ocelli is characteristic of both gamic and wingless parthenogenetic females. On the basis of such characters the aphid types can be placed in a series with the males and gamic females at the extremes and the parthenogenetic females in between. In this series the winged parthenogenetic females are close to the male type and the wingless parthenogenetic females are close to the gamic female type.

From the developmental point of view the expression of the differential characters in the four aphid types suggests that each embryo starts out in one of two directions, either toward the male extreme or toward the female extreme. If development is complete in either direction a male or gamic female results. However, if it is modified so that the expression of maleness or gamic femaleness is incomplete the parthenogenetic females are produced, and they will be either winged or wingless depending on whether the aphids complete development near the male or gamic female extreme.

The validity of this scheme of development can be checked in part by comparison of the differential structures in the aphid types to see if

the parthenogenetic females are in reality intermediate between the two gamic extremes. The characters chosen for this study are hind tibial size and number of antennal sensoria. These two characters were chosen because of their nature which permits careful measurement and comparison, and because males and gamic females differ decidedly in their expression.

It is known that gamic females have swollen hind tibiae and that males and parthenogenetic females have thin hind tibiae, but few actual measurements are on record and little is known of the actual size of parthenogenetic hind tibiae other than that they appear thinner than gamic hind tibiae. Shull (1930) noted the swollen condition of gamic female hind tibiae and also compared gamic females with parthenogenetic females with respect to hind tibial size. However, he used arbitrary comparative numbers instead of actual sizes, and furthermore clumped all parthenogenetic females together making no distinction between winged and wingless forms. Later (1931) using the same method he compared the hind tibiae of winged with wingless gamic-parthenogenetic female intermediates and found that the presence of wings is correlated with thin hind tibiae. Another mention of hind tibial size is made by Shull (1932) in comparing the gamic females of two clones. This time the measurements were made with an ocular micrometer but the length of the micrometer unit is not given, so except for two instances the figures again have comparative value only. The two exceptions are that in clone A the width is 4.3 per cent of the length and in clone B the width is 2.9 per cent of the length.

More adequate figures are available of the numbers of sensoria on the antennae. Shull (1925) finds 4 to 6 on wingless parthenogenetic females, 15 to 18 on winged parthenogenetic females, 4 to 8 on gamic females and 25 to 40 on males. Stiles (1938) agrees with Shull in finding 4 to 6 sensoria on wingless parthenogenetic females and 14 to 18 on winged females. He also lists a series of 199 counts on intermediate winged aphids. These figures were used by the author to compute the mean and standard deviation and are included in Table IV of this paper. Stiles (1939) concluded on the basis of his study of intermediates that sensoria number is very definitely related to the winged condition in aphids and he states that he found no closely graded series of sensoria number from one extreme to the other in the intermediates.

MATERIAL AND METHODS

The aphids used in this study were taken from stock cultures of aphids grown on potato plants in the laboratory and killed by immersion in dioxane. The aphids were left in the dioxane until they could be transferred to slides and covered with balsam. The time in dioxane varied but never extended over a period of one week. Measurements were made of width and length on both right and left hind tibia, a filar micrometer being used for width and an ocular micrometer for length. The measurements were recorded in millimeters. Counts of antennal sensoria were made on both antennae with a compound microscope.

HIND TIBIAL WIDTH

The means and standard deviations of the widths of aphid hind tibiae are given in Table I, an inspection of which shows that gamic females have the widest hind tibiae, the wingless parthenogenetic females the next widest, the winged females next while the males have the thinnest. The differences between all types are statistically significant.

A difference is considered significant when the difference between two means is a least twice the standard error of the difference between means.

TABLE I

A Comparison of Hind Tibial Width Measured in Millimeters at the Widest Part

Type	n	Mean in mm.	Standard Deviation
Gamic Female	199	.076 ± .0004	.006 ± .0003
Wingless Par. Female	188	.060 ± .0003	.004 ± .0002
Winged Par. Female	199	.048 ± .0002	.003 ± .0001
Male	195	.040 ± .0002	.003 ± .0002

LENGTH OF HIND TIBIAE

The lengths of the hind tibiae also were measured and the results are given in Table II. The longest hind tibiae are found on wingless parthenogenetic females. The hind tibiae of winged parthenogenetic females are shorter and the difference is significant. In males and gamic females the hind tibiae are of the same length and are significantly shorter than either of the parthenogenetic types.

TABLE II

Length of Hind Tibiae in Millimeters

Type	n	Mean in mm.	Standard Deviation
Wingless Par. Female	200	2.62 ± .015	.22 ± .01
Winged Par. Female	203	2.44 ± .011	.16 ± .007
Male	196	2.0 ± .014	.20 ± .01
Gamic Female	199	2.01 ± .015	.21 ± .01

RATIO OF WIDTH TO LENGTH

The width of each hind tibia was divided by its length and the average w/l ratio computed. The results are given in Table III. The gamic females have the widest hind tibiae in relation to length. The wingless parthenogenetic females have the next widest while winged

parthenogenetic females and males have the same width. Both winged females and males have narrower hind tibiae than gamic females and wingless parthenogenetic females.

TABLE III

RATIO OF WIDTH TO LENGTH OF HIND TIBIAE

Type	n	Mean in mm.	Standard Deviation
Gamic Female	197	.038 ± .0002	.003 ± .00015
Wingless Par. Female	187	.023 ± .0002	.002 ± .00012
Winged Par. Female	197	.0197 ± .0009	.001 ± .0006
Male	195	.0199 ± .001	.001 ± .0007

ANTENNAL SENSORIA

A comparison of antennal sensoria numbers is given in Table IV. Gamic females have fewer sensoria than any of the other types with wingless females a close second. The difference between these two types of females is significant but small. Intermediate winged females have more sensoria than wingless females but fewer than winged females, while males have many more than any of the other types. All differences shown in Table IV are significant.

TABLE IV

A COMPARISON OF ANTENNAL SENSORIA IN APHIDS

Type	n	Mean in mm.	Standard Deviation
Gamic Female	199	4.32 ± .09	1.27 ± .064
Wingless Par. Female	186	4.91 ± .076	1.04 ± .054
Intermediate Winged Female[1]	199	6.6 ± .143	2.02 ± .101
Winged Par. Female	200	15.33 ± .12	1.69 ± .084
Male	194	52.63 ± .57	7.94 ± .403

DISCUSSION

The measurements of hind tibial width support the concept that the parthenogenetic females are intermediate between the gamic female type and the male. If absolute width is used as a criterion the wingless parthenogenetic females are similar to, but not quite like the gamic females. Likewise the winged females are similar to, but not quite like the males. If relative width is used the same relationship is found except that here the winged females and males are exactly the same. Presumably the length-width ratio represents a better expression of the

[1]Data taken from Stiles (1938).

relationship between the different types of tibia, in which case the winged females are mosaic for this character rather than intermediate. The character in wingless parthenogenetic females seemingly is intermediate.

The counts of antennal sensoria also indicate that parthenogenetic females may be considered intermediate between gamic females and males.

SUMMARY

The measurements of hind tibial width and counts of antennal sensoria suggest that the expression of these characters in parthenogenetic females is intermediate between males and gamic females.

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1939. The time of embryonic determination of sensoria and antennal color and their relation to the determination of wings, ocelli, and wing muscle in aphids. Bio. Bull., 76: 442–447.

STUDIES IN NEOTROPICAL MALLOPHAGA (III). TINAMIDAE No. 2, by M. A. CARRIKER, JR. Proceedings of the U. S. National Museum, No. 3180, Vol. 95, pp. 81–233; 29 figs. Washington, D. C., 1944.

Like so many entomological papers in the Proceedings of the United States National Museum, the third part of the Studies in Neotropical Mallophaga is a milestone in the taxonomy of the order. As a specialist in another order of insects who might possibly want to identify a few biting lice the reviewer notes the absence of keys as an unusual omission in such a comprehensive survey, but since insects of this order, and certainly of this family, are not likely to fall into the hands of entomological dilettantes, the omission can hardly be serious. The Studies are among the taxonomic contributions which take a permanent place in the intricate fabric of insect classification.—A. W. L.

STUDIES ON THE BIOLOGY OF THE WEBBING CLOTHES MOTH (TINEOLA BISSELLIELLA HUM.), by GRACE H. GRISWOLD. Cornell University Agricultural Experiment Station, Memoir 262, 59 pages, 24 figs. Ithaca, N. Y., 1944.

Detailed inquiry into the private life of household pests has apparently been an unattractive entomological adventure. The omission has been corrected here for *T. bisselliella* Hum., for this is decidedly a detailed inquiry, taking into consideration the effects of temperature, humidity and type of food on the mortality among these insects. In the painstaking procedures and extensive data it is an admirable biological study and should be most interesting as such. Since most of us are more concerned about discouraging than encouraging the little beasts, it leads to the facetious wish that fishmeal could be more abundant in our homes, to the mutual advantage of *bisselliella* and our clothing. And surely any inspiration to facetiousness denotes an interesting contribution.—A. W. L.

EFFECT OF POTASSIUM FLUORIDE AND PYRETHRUM ON PERIPLANETA AMERICANA (L.) AFTER HEMOCYTES ARE BLOCKED WITH CHINESE INK OR NEPHROCYTES ARE STAINED WITH TRYPAN BLUE

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The variation in insect resistance to insecticides is a common phenomenon observed in testing materials for toxicity. Environmental factors, such as temperature, humidity, and diet, have been found to affect resistance, but few attempts have been made to correlate it with physiological conditions within the insect. It is probable, however, that the effect of the environmental factors was to change the physiological state of the insect, which in turn determined its resistance.

One method of studying the physiological function of an organ or a tissue in an insect is to treat the insect with some material that will have a marked effect on that organ or tissue and little effect on the remaining cells. When such a treatment is followed by an application of insecticide, any change in resistance can be assumed to be related to the change in function of the organ or tissue affected by the original treatment.

Such a study was made by Yeager, McGovran, Munson, and Mayer (1942) with sodium arsenite and nicotine as the test insecticides. They injected carbon particles (Chinese ink) into large nymphs of the American cockroach (*Periplaneta americana* (L.)). Certain blood cells (hemocytes) in the roaches phagocytized these particles, and upon becoming filled these cells tended to stick together and form aggregates of cells, some of which, no doubt, lodged among the various tissues of the body and no longer circulated with the blood stream. The quantity of carbon particles injected was adjusted so that many blood cells appeared heavily loaded and very few, if any, carbon particles were seen floating free in the blood plasma. In other tests trypan blue, which stains the nephrocytes (pericardial cells), was injected into roaches, the quantity being adjusted so that these cells were deeply stained but the remaining tissues showed only traces of dye. Under such conditions, if these cells are partly responsible for the roaches' resistance to the insecticides and the carbon particles or the dye interfered with this function, the resistance of the roaches should decrease. Following this procedure Yeager *et al.* found that the carbon particles reduced the resistance of roaches to sodium arsenite to a marked degree and to nicotine to a slight degree, but that trypan blue did not change the resistance of roaches to either insecticide.

In the present investigation, which is a continuation of this work, solutions of potassium fluoride[1] in water or pyrethrum extract in acetone were applied to roaches that had been injected with Chinese ink or trypan blue.

MATERIALS AND PROCEDURE

The technique employed in these tests was the same as that used by Yeager *et al.* The roaches were injected, at the rate of 0.01 ml. per gram of body weight, with (1) a suspension of Chinese ink in saline, (2) saline containing trypan blue, or (3) saline, and were confined individually in shell vials closed with screen wire. Approximately 24 hours after the injection the roaches were treated with acetone or acetone containing pyrethrum extract (0.4 mg. of pyrethrins per milliliter), or with water or water containing potassium fluoride, 0.30 gm. per milliliter for roaches injected with trypan blue and 0.35 gm. for the ink-injected roaches. These concentrations of potassium fluoride were used to obtain suitable levels of mortality.

The potassium fluoride and pyrethrum solutions were applied at rates of 0.0025 and 0.005 ml., respectively, per gram of body weight.

The solutions or carriers were placed between the wing pads and the body surface of the nymphs. The insects were observed daily for 14 days to determine the mortality. Each treatment was applied to three groups of roaches, approximately 10 insects being used in each test in the pyrethrum series and from 15 to 20 insects in the fluoride series.

The roach nymphs weighed from 455 to 1590 mg. each, with an average of 727 mg. The standard deviation of the distribution was 172 mg. Of the nymphs used, 52.4 per cent were males.

RESULTS

The results obtained when roaches injected with carbon particles (Chinese ink) were treated with potassium fluoride are given in figure 1. On the 5th day after the insecticide was applied the mortality of the roaches injected with ink suspension was higher than that of roaches injected with saline without ink, but on the 14th day the reverse was true. This crossing of the mortality curves was confirmed in a second series of tests (not illustrated) with the same materials, although the general level of mortality was much lower. The significance of the differences in mortality of the poisoned insects given in figure 1 was determined by Student's method for the 5th and 14th days after application of the insecticide. There appeared to be no significant difference on the 5th day but an approach to the significance level (odds of approximately 17 to 1) on the 14th day. When the data from the second series of tests were combined with the data given in figure 1, a significant difference was found on both the 5th and 14th days. Observations on

[1]Potassium fluoride was used instead of the commonly used insecticide sodium fluoride, because its greater solubility in water allowed the preparation of a more concentrated solution so that the desired amount of insecticide could be applied in a smaller volume of water. A large volume of fluoride solution applied to the external surface of the roach might have resulted in considerable loss of material in some instances and possibly the ingestion of some of the poison.

the roaches in the second series were continued through the 35th day after treatment, but without significant change in the relative mortalities.

Following treatment with pyrethrum solution roaches injected with carbon particles showed some difference in total mortality, and greater difference in net mortality, from roaches not injected, but the differences were not statistically significant (fig. 3). The injection of trypan blue (figs. 2 and 4) had little effect, if any, on the resistance of the roaches to the insecticides applied.

TABLE I

EFFECT OF INJECTIONS OF CARBON PARTICLES (CHINESE INK) OR TRYPAN BLUE IN SALINE AND THE SUBSEQUENT EXTERNAL APPLICATION OF POTASSIUM FLUORIDE OR PYRETHRUM ON THE MOLTING AND MORTALITY OF *Periplaneta americana*

Treatment*	Percentage of Total Roaches That Molted	Per Cent Mortality Among Roaches That Molted	Per Cent Mortality Among Roaches That Did Not Molt
Carbon particles, trypan blue, or saline injected preceding external applications of—			
Potassium fluoride in water	16	86	41
Water	24	21	1
Pyrethrum in acetone	9	89	57
Acetone	28	66	14
Water or acetone applied externally following injection with—			
Trypan blue in saline	30	40	7
Saline	36	42	12
Carbon particles in saline	19	58	7
Saline	18	33	3

*Each pair of treatments was applied to a single population of roaches, but different pairs were applied to different populations.

During the 14-day observation period any subnormality in the activity of the roaches when the vials containing them were shaken was recorded. These data show that the average period of subnormal activity preceding death was 2.2 days for the pyrethrum-treated roaches and 1.7 days for those treated with potassium fluoride.

In Table I are summarized the observations on the molting of the roaches. As molting would introduce another variable into the effect of the treatments, none of the results with roaches that molted are included in figures 1–4. During the observation period the percentage of roaches that molted in a single experiment ranged from 5 to 45, the average being 19.2 per cent. The insects molted from the first to the twelfth day after treatment. The average period from treatment to molting was

4.5 days for the insects that survived and 3.9 days for those that succumbed. The average period from molting to death was 1.75 days for roaches treated with potassium fluoride as compared with 2.5 days for similar unpoisoned insects. Pyrethrum-treated roaches succumbed 1.5 days after molting as compared with 2.0 days for unpoisoned roaches.

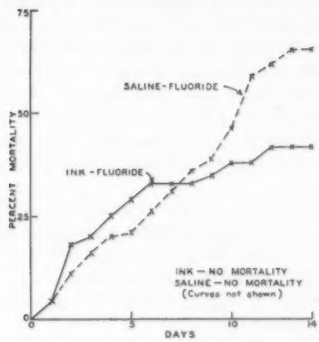

FIG. 1–CHINESE INK – POTASSIUM FLUORIDE

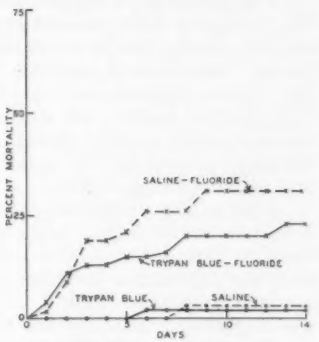

FIG. 2–TRYPAN BLUE – POTASSIUM FLUORIDE

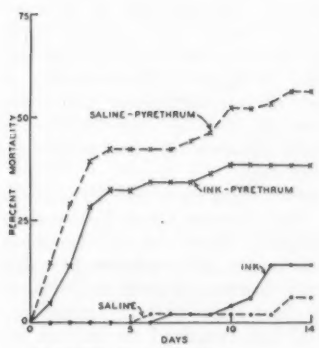

FIG. 3–CHINESE INK – PYRETHRUM

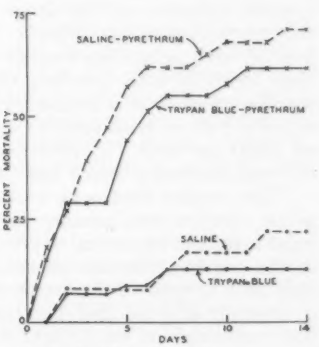

FIG. 4–TRYPAN BLUE – PYRETHRUM

FIGS. 1–4. Effect of injections of Chinese ink or trypan blue on the mortality of *Periplaneta americana* subsequently treated externally with potassium fluoride or pyrethrum: Fig. 1, Chinese ink followed by potassium fluoride; fig. 2, trypan blue followed by potassium fluoride; fig. 3, Chinese ink followed by pyrethrum; fig. 4, trypan blue followed by pyrethrum.

DISCUSSION

The crossing of the curves in figure 1 between the 7th and 8th days after the application of potassium fluoride indicates that the resistance of the roaches injected with carbon particles prior to poisoning was reduced during the first half of the observation period but was increased later in this period. The action of potassium fluoride was different from the action of pyrethrum (fig. 3) and also, as reported by Yeager

et al., from that of sodium arsenite and nicotine. The results might have been due in part to the adsorption of some normal constituent or constituents of the plasma in the period between injection and phagocytosis of the carbon particles. However, if the carbon particles adsorbed the poisons, the latter must have first been taken up by the blood cells.

The injection of trypan blue in saline did not significantly change the resistance of the roaches to potassium fluoride or pyrethrum (figs. 2 and 4). These results are similar to the findings of Yeager *et al.* with sodium arsenite and nicotine. It will be noted that the mortality of the trypan blue-injected insects, both poisoned and unpoisoned, was only slightly below (not statistically significant) the mortality of the saline-injected roaches during the last 6 days, and also that the net mortality caused by the pyrethrum was the same in both trypan blue and saline-injected roaches.

Among the pyrethrum-treated insects (fig. 3) the mortality was higher throughout the 14-day period in those injected with saline alone than in those injected with ink in saline. This difference was not statistically significant, however; nor was the mortality of the unpoisoned roaches injected with ink in saline significantly higher than that among the unpoisoned ones injected with saline alone.

The curves in the different figures are not directly comparable, as the data were obtained at different times and on different lots of insects. It will be observed, however, that the level of mortality may have a marked influence on the shape of the curve. For example, in figure 1 the mortality of the insects injected with saline and subsequently treated with potassium fluoride continues to rise until the 13th day and then levels off after reaching 66 per cent. In figure 2 the mortality of roaches treated in a similar manner rises at approximately the same rate for 6 days, with another slight rise on the 9th day, and then levels off at 31 per cent. In other words, in this instance the low maximum kill was reached in much less time than the high.

The roaches that were treated with pyrethrum were affected within a few minutes and became very active, this activity being followed in most instances by partial or complete paralysis. However, the condition of the roaches was not recorded until 24 hours after treatment. By this time several of the roaches were dead, some appeared moderately or severely affected and died one or more days later, and the remainder had recovered or were slightly subnormal but returned to normal by the end of 48 hours. The effect of pyrethrum was different from that of nicotine (Yeager *et al.*), which caused a much more prolonged period of subnormality in many of the roaches.

Table I shows that under the conditions of these tests the mortality was considerably higher among the molting than the nonmolting roaches, and among the poisoned insects, whether they molted or not, than among the unpoisoned ones. These results also indicate that, in addition to their killing action, the insecticides may have inhibited molting in some cases. This effect appears slightly more pronounced among pyrethrum-treated roaches. The injection of ink or dye apparently did not inhibit molting. Trypan blue appeared to cause no mortality of roaches that molted, whereas carbon particles may have increased mortality.

CONCLUSION

From the results previously reported by Yeager *et al.*, it appears that the injection of Chinese ink suspended in saline, which heavily loaded the hemocytes with carbon particles, caused a marked reduction in the resistance of the insects to sodium arsenite and probably slightly reduced their resistance to nicotine. In the present investigation, the same treatment reduced the resistance of the nymphs to potassium fluoride at some time during the first half of the observation period and increased their resistance by the end of this period; there was also a slight increase in resistance to pyrethrum. It seems evident that the injection of the Chinese ink in saline changed the physiological state of the insects in such a manner that they reacted anomalously to all the poisons applied, especially the inorganic poisons. When a solution of trypan blue in saline was injected into the roaches, however, it stained the nephrocytes blue but did not appreciably change the resistance of the insects to either the organic or inorganic poisons.

SUMMARY

Nymphs of the American cockroach (*Periplaneta americana* (L.)) were injected with carbon particles (Chinese ink) or trypan blue in saline and then poisoned by the external application of potassium fluoride in water or pyrethrum in acetone, to determine if the injections affected the resistance of the roaches to the poisons. The injection of carbon particles lowered the resistance to potassium fluoride for a time during the first half of the observation period but caused a marked rise in resistance by the end of the period. The injection of carbon particles appeared to increase the resistance of the roaches to pyrethrum slightly, but the difference was not statistically significant. The injection of trypan blue apparently did not change the resistance of the roaches to potassium fluoride or pyrethrum. Some observations on activity and molting are given and discussed.

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Yeager, J. Franklin, E. R. McGovran, Sam C. Munson, and **E. L. Mayer.** 1942. Effect of blocking hemocytes with Chinese ink and staining nephrocytes with trypan blue upon the resistance of the cockroach *Periplaneta americana* (L.) to sodium arsenite and nicotine. Ann. Ent. Soc. Amer. 35: 23–40, illus.

CHECKLIST OF THE COLEOPTEROUS INSECTS OF MEXICO, CENTRAL AMERICA, THE WEST INDIES, AND SOUTH AMERICA, PART 2, by RICHARD E. BLACKWELDER. United States National Museum, Bulletin 185, 341 pages, Washington, D. C., 1944. For sale by the Superintendent of Documents, Washington, D. C. Price $0.30.

The format of National Museum publications is too familiar to scientists to require comment and the extremely useful but equally prosaic nature of checklists offers no meat to a reviewer. One can only notice this second part of Blackwelder's checklist as an extremely helpful addition to the literature on the Coleoptera of the New World with the gratitude that should go to specialists who give their time to such work when it might better serve their own interests in other studies.—A. W. L.

ELEVEN NEW SPECIES OF EURYTOMA FROM MEXICO
(Eurytomidae: Hymen.)

PARTS III AND IV. BREVIURA AND AUREATA GROUPS

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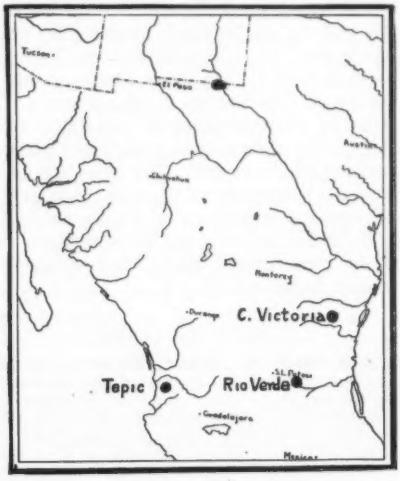
In two preceding papers eleven new species of the genus *Eurytoma* were described from Mexico. The first paper dealt with 5 new species of the so-called Mucronura group (Bugbee, 1941a) and the second with 6 new species of the Atrateges group (Bugbee, 1941b). To conform with the others, the new species described herein are assigned to the Breviura and Aureata groups. No description or nomenclatorial



MAP No. 1. Type localities of species of *Eurytoma*, Aureata Group.

standing has been given these four groups, as their correct status cannot be finally determined until all the North American species of the genus *Eurytoma* are studied and the genus revised. However, they are quite distinct as far as the Mexican material is concerned. It is probable that all four groups may extend into the southern part of the United States.

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[1]Contribution No. 45 from the Zoology Department of Fort Hays, Kansas, State College, Hays, Kansas.

The new species of the Breviura group were bred from galls belonging to the cynipid genus, *Disholcaspis*. The host galls were collected in the fall of 1931 by Dr. A. C. Kinsey in the Western Sierra mountain range of Mexico (Map No. 1).

A check of these parasites has failed to reveal the same degree of close correlation with the host species below the generic level that was found, for instance, in the species of the Mucronura group. Although all the new species of *Eurytoma* of the Breviura group described in the following pages were bred from *Disholcaspis* galls, close relatives among

MAP No. 2. Type localities of nine new species of the genus *Eurytoma*, Breviura Group.

the parasites were bred from *Disholcaspis* galls placed in unrelated complexes. Furthermore, the nine new species of the Breviura group show evidence, as noted in connection with their descriptions, of representing at least five different complexes which do not coincide with the complexes indicated by Dr. Kinsey for the *Disholcaspis* hosts. This might seem contradictory but it has been pointed out before (Bugbee, 1941a) that sometimes parasites show close correlation with their hosts, i. e., one species of parasite occurs on one species of host or on several closely related species of hosts, while in other cases a parasite

may attack several unrelated species of hosts belonging, even, to different orders. Here, at least, the nine species are confined to the single genus (*Disholcaspis*) even though they do not carry the relationship through to the complexes. After careful consideration it is believed that this apparent contradiction may not be valid. Two possible explanations may be considered: (1) The species of *Eurytoma* may be parasitic on inquilines or on other species of primary parasites of the gall-making species and will show closer correlation with them than with the true gall-maker. (2) The species of *Eurytoma* may be primary parasites of the gall-making host species but have not developed as close a correlation with their hosts as the more specialized species of the Atrateges and Mucronura groups. Students of insect phylogeny have held that extreme host restriction represents a high degree of specialization, and it is found to occur most often in species of relatively recent origin. Conversely, generalized host relationships occur most often among species representing older evolutionary stock from which the more recent, specialized species may have arisen. In this case, the fact that the species of the Breviura group fail to show as close a correlation with the hosts as in the other two groups, may mean that they represent more generalized stock and are thus not as highly specialized in their host relationships as the species of the Mucronura and the Atrateges groups.

Correlated with the more generalized host preferences is a greater degree of structural differences between the species of the Breviura group which makes them more distinct and easier to separate than the species of either the Atrateges or Mucronura groups. This greater degree of structural modification in addition to the generalized host relationship suggests that the second explanation offered above seems to be the more likely. If life-history studies can be made some day, additional evidence for or against this hypothesis may be uncovered.

The difficulties which would have to be overcome in working out the life-histories of the parasites would be much the same as those outlined by Dr. Kinsey (1942, page 167) in working out the life-histories of the gall-makers.

It should be emphasized here that the citation of the host gall-making species after each description of the species of *Eurytoma* merely means that the species of *Eurytoma* was bred from galls of that host species but does not mean that the species of *Eurytoma* were necessarily parasitic on the gall-making species. The species of *Eurytoma*, instead of parasitizing the gall-making species, may have been parasitic on other species of primary parasites or inquilines belonging to different families or even orders.

The Breviura group may be told from the Mucronura, Atrateges and Aureata groups by the very short, stubby, exposed tip of the dorsal valves; the short postmarginal vein which is usually one-half or less the length of the marginal; the lack of noticeable lateral compression of the abdomen; the relatively weakly developed genitalia with no tendency to coil upon itself in most of the species, brown tegulae, and the different host relationships.

The descriptions of the new species follow:

BREVIURA GROUP

PART III

Eurytoma breviura, n. sp.

(Plate I, figs. 1 and 5)

Female.—Length, 2.5–4.3 mm.; average 3.6 mm. Abdomen oval to rectangular from the side; no great dorsal extension, anteriorly, so that the dorsal outline of the abdomen slopes gradually backward and then drops abruptly to the level of the protruding tips of the genitalia; depth averages 1 mm. (range .80–1.2 mm.) and the width, from above, .75 mm. (range .50–.90 mm.); fine scaling on lateral aspect of segment 6 somewhat reduced, covering only about one-third to one-half of the lower surface; plays out dorsally and reaches posterior edge of segment only towards base; exposed tips of dorsal valves short and stubby; genitalia averages in length 1.8 mm. (range 1.7–1.8 mm.) and in height 1.1 mm. (range 1.1–1.2 mm.); dorsal and ventral valves turn dorsally anteriorly but there is no tendency for ventral valves to bend posteriorly; vertical dimension of dorsal valves may be about same width for horizontal length (range .15–.30 mm., average .22 mm.); angle formed by the horizontal and tangent lines—39 degrees; tips of ventral valves brown; stylet arch halfway between a horizontal and vertical plane; (See Plate I, fig. 1). Legs with the coxae black; black infuscation on most femurs; occasionally lacking on front-femurs; black appears as spots on outer face of fore- and mid-femurs; encircles middle of hind-femurs, covering all but tips; black infuscation in middle of hind and mid-tibiae and on front-tibiae of some. Thorax with the tegulae brown. Propodeum with a shallow median depression, down the middle of which is a ridge which is quite distinct dorsally but practically obliterated ventrally; ridges marking lateral edges of depression indistinct; short irregular lateral ridges extend from central ridge; at top of central ridge are two large oval areas, one on each side of central ridge; above these is a shallow crescent-shaped pit; at base of median depression is a round, deep pit; median depression about same width for whole length. Head with a deep triangular pit under the eye. Antennae with basal half of the scape brown; rest black. Wings average in length 3.3 mm. (range 3.2–3.6 mm.); veins brown; heavy and distinct; postmarginal vein, which averages .20 mm. (range .17–.22 mm.) in length, less than half as long as the marginal, which averages .43 mm. (range .37–.50 mm.) in length; postmarginal truncate at outer tip; stigmal club rectangular and with a rounded base. Wing-body ratio of 1.09.

Male.—Length, 2 to 3.6 mm.; average 2.8 mm. The males are quite variable; in some the tegulae are black and in others brown. In wing characteristics they all fit into this complex as well as this species. The wing veins are dark brown and heavy; postmarginal vein is less than half the length of the marginal; postmarginal averages .20 mm. (range .10–.27 mm.) in length and the marginal .41 mm. (range .32–.47 mm.). Black infuscation on the legs of those with black tegulae is more extensive than those with brown tegulae,

occurring on all tibiae and femurs; increasing from front to rear. Males with brown tegulae have no black infuscation appearing on the fore-legs but usually some is present on mid-femurs, hind-femurs and tibiae.

Types.—31 females and 16 males; holotype female and allotype male as well as paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Jilotepec, 7 miles northwest, State of Mexico, Mexico; elevation 9500 feet; galls collected January 16, 1932; males and females emerged spring of 1932; also a second batch of males and females that emerged the spring of 1933 to as late as July 20, 1933.

Host.—Labels read, from galls of an undescribed species related to *Disholcaspis bassettii*, Kinsey det., on *Quercus purpusi*, Kinsey coll.

Range.—Known only from the type locality (Jilotepec).

This species seems to resemble the next species more than any of the others. It differs from it, however, in the wing-body ratio, relation of the length of the marginal and postmarginal veins, coloration of the legs, host relationships, and shows an incomplete central ridge down the center of the propodeum.

The polymorphism of the males as displayed in the black and brown tegulae is interesting. At first the males with the black tegulae were considered to belong to a distinct species as well as a distinct group, but in most of their other characteristics they resembled the Breviura group and fell within the limits of this species. The presence of the black tegulae in this case may represent a mutation and suggests a possible origin of this character as it appears in the Atrateges group (Bugbee, 1941b). It may also imply that the Atrateges and Breviura groups are closely related. At any rate it shows that so-called diagnostic characters cannot be relied upon in one hundred per cent of the cases. It is interesting to note further that all the black tegulae males emerged the first spring (1932) while two of the brown tegulae males emerged in the spring of 1932 and the rest in the spring of 1933. The black tegulae males may represent offspring from eggs laid by a single, unfertilized female.

In common with other species of this genus, i.e., *E. rhois* (Bugbee, 1939), *E. fulva* (Bugbee, 1941b), etc., this species exhibits a record of emergence over a two-year period (1932 and 1933).

Eurytoma linearis, n. sp.

(Plate I, fig. 2)

Female.—Length, 2.8–3.9 mm.; average 3.5 mm. Abdomen rectangular in general outline from a lateral view; no great dorsal arching of anterior part of the abdomen; depth from the side averages 1.1 mm. (range .85–1.1 mm.) and width from above averages .80 mm. (range .60–.87 mm.); exposed tips of the dorsal valves short and stubby; average .12 mm. (range .10–.15 mm.) in length. Genitalia averages 1.7 mm. in length and in height 1.4 mm.; dorsal valves turn dorsally, anteriorly; ventral valves turn dorsally also but show no tendency to bend posteriorly; stylet arch about halfway between a vertical and a horizontal plane; dorsal valves narrow for horizontal

length averaging .15 mm.; angle formed by the horizontal and tangent lines—45 degrees; extreme outer tip of ventral valves black. Legs with the main basic color brown; black infuscation most often on all femurs; occurs as spots on fore- and mid-femurs, but covers most of hind-femur; tibiae usually with no black; occasionally a small amount on hind-tibiae; tips of femurs and tibiae brown to lemon yellow. Tegulae brown. Propodeum with a central ridge down middle of median depression; depression divided unequally by faint lateral ridges emanating from central ridge; spaces between lateral ridges appear smooth and shiny; at base of central ridge is a large, rectangular depression surrounded by a distinct ridge; at top of ridge is a very shallow indistinct pit; whole central depression about same width for entire length. Head with the eyes not bulgy laterally and quite flat across the front. Antennae with the basal half of the scape yellow; rest black. Wings average in length, 2.6 mm. (range 2.0–3.0 mm.); veins yellow and thin; postmarginal vein about one-half or more length of the marginal; postmarginal averages in length .25 mm. (range .22–.27 mm.) and the marginal .40 mm. (range .40–.42 mm.); stigmal club shallow and very slightly rounded basally. Wing-body ratio of 1.34.

Male.—Average length is 2.75 mm. Coxae black; black on hind-femurs and tibiae; slight amount on mid-femurs and tibiae; none on front-femurs and tibiae. Scape yellow only on lower one-fourth or less; rest black. Wing veins dark brown.

Types.—6 females and 2 males; female holotype and allotype male along with paratypes of both sexes in Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Morelia, 14 miles east, State of Michoacan, Mexico, 7000 feet altitude; galls collected December 27, 1931; males and females emerged spring of 1932.

Host.—Labels read, from galls of an undetermined species of the *Disholcaspis perniciosa* complex, Kinsey det., on *Quercus conglomerata*, Kinsey coll.

Range.—Known only from Morelia, in the central part of the State of Michoacan.

This species is closely related to the preceding species (*E. breviura*). It may be distinguished from *E. breviura*, however, by the presence of less black infuscation on the legs, longer postmarginal vein in relation to the length of the marginal, wing-body ratio, and host relationships.

Eurytoma lata, n. sp.

Female.—Length, 3.2 to 3.6 mm.; average 3.4 mm. Abdomen oval from a lateral view; width equals .75 mm. (range .70–.87 mm.) and depth 1.0 mm. (range .90–1.1 mm.); exposed tip of dorsal valves short and stubby, averaging .15 mm. (range .12–.17 mm.) in length; a few (3–6) short white hairs occur on the latero-dorsal aspect of segment 6; fine pitting on segment 6, laterally, somewhat reduced; covers one-half or less of surface. Genitalia with the dorsal valves wide for horizontal length giving them a very stout appearance (average .25 mm.); whole structure averages 1.4 mm. in length and .9 mm. in height; dorsal valves turn only slightly dorsally, anteriorly;

ventral valves turn dorsally but do not tend to bend back on themselves; angle formed by the horizontal and tangent lines—38 degrees; stylet arch halfway between a vertical and a horizontal plane; much less dorsal curvature of both valves than in other species of this group with the exception of *E. levidensis*. Legs with the coxae black; femurs may be all yellowish brown or may show varying amounts of black infuscation; in most cases front and mid-femurs are brown and hind-femurs shows a splotch of black medially; tibiae in most cases all yellowish brown; in a few cases black infuscation may appear on mid and hind-tibiae. Tegulae brown. Propodeum with a shallow median depression; wider at top than at bottom; central ridge extends about halfway down center of depression; below where central ridge plays out depression divided by several horizontal ridges into small rectangular areas; at base of depression is a deep rectangular pit much wider than base of depression; at top of depression on each side of central ridge are two large shiny rectangular areas. Head with an indication of a shallow pit below eye. Wings average in length 2.7 mm. (range 2.5–2.8 mm.); veins light brown in color; heavy; postmarginal vein averages .17 mm. (range .12–.20 mm.) in length and the marginal .35 mm. (range .32–.37 mm.); thus the postmarginal is about half the length of the marginal; stigmal club tends to be more nearly square than rectangular and basally it is rounded. Wing-body ratio of 1.25.

Male.—No males are known.

Types.—6 females; female holotype and paratypes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Atequiza, five miles east; State of Jalisco, Mexico; altitude 6500 feet; galls collected on December 12, 1931; females emerged July 15, 1932.

Host.—Labels read, from an undescribed species belonging to the *Disholcaspis sulcatus* complex, Kinsey det.; on *Quercus laxa*, Kinsey coll.

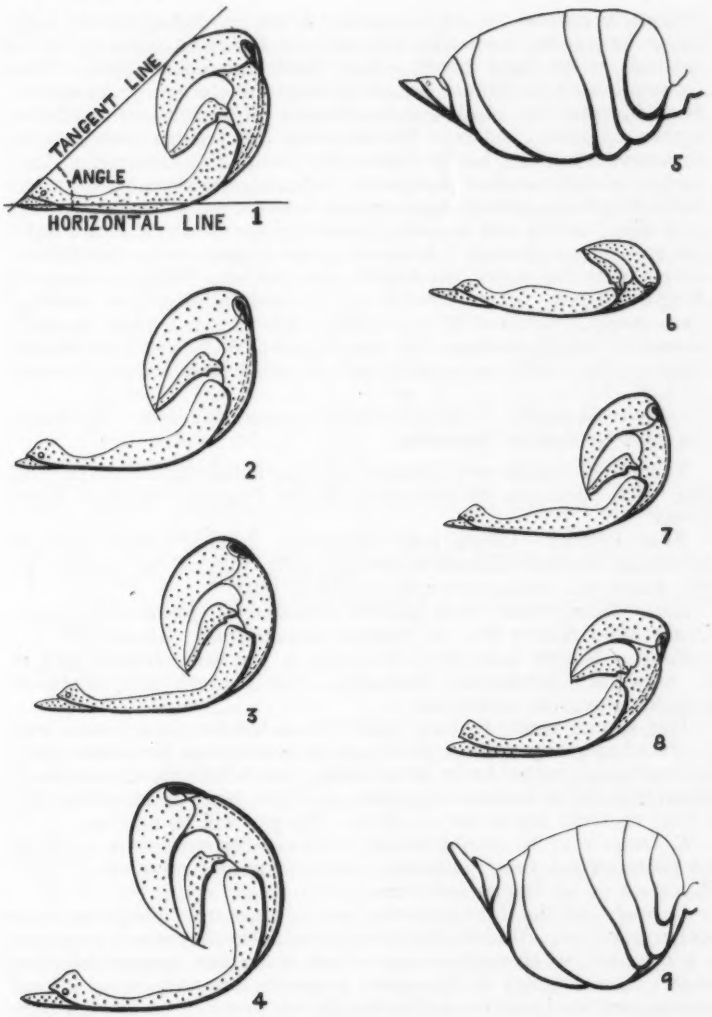
Range.—Known only from the type locality.

E. lata resembles the preceding material from Jilotepec and Morelia more than any of the other new species. It can be separated from them by its shorter marginal and postmarginal veins, smaller and stouter appearing genitalia, and the different host relationships.

Eurytoma imago, n. sp.

(Plate I, fig. 3)

Female.—Length 2.5 to 3.3 mm.; average 2.9 mm. Abdomen black, oval to rectangular in outline from lateral view; no great dorsal arching of the anterior part of the abdomen; depth averages .85 mm. (range .75–1 mm.); width .60 mm. (range .55–.70 mm.); fine scaling on lateral aspect of segment 6 prominent basally and covering about one-half to three-fourths of surface; segment 6 averages at widest point .50 mm. and is wider than segments 4 and 5 combined, which average .40 mm.; exposed tip of dorsal valves short; genitalia averages in length 1.4 mm. (range 1.3–1.5 mm.) and in height .95 mm. (range .90–1 mm.); both dorsal and ventral valves turn dorsally, anteriorly, and stylet arch is close to a vertical plane; dorsal valves



Genitalia and Abdomens of New Species of the genus *Eurytoma* from Mexico (Breviura Group):

FIG. 1. Female genitalia of *Eurytoma breviura*, showing angle used in descriptions. 2. Female genitalia of *Eurytoma linearis*. 3. Female genitalia of *Eurytoma imago*. 4. Female genitalia of *Eurytoma excellens*. 5. Female abdomen of *Eurytoma breviura*. 6. Female genitalia of *Eurytoma levidensis*. 7 Female genitalia of *Eurytoma venula*. 8. Female genitalia of *Eurytoma subfusca*. 9. Female abdomen of *Eurytoma excellens*.

extremely narrow for all of horizontal length, averaging .12 mm.; angle formed by horizontal and tangent lines—45 degrees; tips of ventral valves light brown. Legs with the coxae black; black infuscation on all femurs becoming progressively greater in amount from front to rear; black also on all tibiae; tips of femurs and tibiae, brown to lemon yellow. Thorax with the tegulae brown. Propodeum with a fine barely discernible central ridge extending down middle of slight median depression; indications of short lateral ridges extending from central ridge; spaces between lateral ridges smooth and shiny; at top and bottom of central ridge are shallow pits which do not appear divided. Antennal joints appear to be moniliform; scape black for upper two-thirds; rest yellow. Wings average in length 2.3 mm. (range 1.8–2.5 mm.); veins light yellow; marginal vein longer, averaging .30 mm. (range .25–.35 mm.), than the postmarginal, which averages .15 mm. (range .15–.17 mm.) in length; stigmal club small, rectangular with rounded base; wing-body ratio of 1.26.

Male.—Length, 1.9 to 2.6 mm.; average 2.2 mm. Specimens too poor for further description.

Types.—13 females and 5 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Matachic, 3 miles north, State of Chihuahua, Mexico; altitude 6700 feet; galls collected on October 21, 1931; males and females emerged, spring of 1932.

Host.—Labels read, from galls of *Disholcaspis* (*perniciosa*) *punicea* (Kinsey MS.) Kinsey det., on *Quercus chihuanuensis*, Kinsey coll.

Range.—Known only from Matachic in the west, central part of the State of Chihuahua. Probably extends north and south of Matachic along the mountains.

This species seems to have many characteristics in common with the preceding group of three species, all of which occur far to the south. This may be accounted for by the collecting which failed to obtain closely related material in between Atequiza and Matachic. In all probability as more material comes out of Mexico this gap will be filled in.

E. imago may be distinguished by its smaller size, short marginal and postmarginal veins, propodeal sculpturing and presence of black infuscation on all femurs and tibiae.

E. imago and the three preceding species make up a group that have much in common. Under ordinary circumstances they would be placed in a complex by themselves apart from the other species described herein. The complex is not given a name, however, as additional material and study are needed before the relationships of the Breviura group can be definitely determined.

Eurytoma levidensis, n. sp.

(Plate I, fig. 6)

Female.—Length ranges from 3.0 to 3.4 mm.; average 3.2 mm. Abdomen rectangular from a lateral view and plump; no great dorsal extension anteriorly so that dorsal surface of abdomen slopes gently posteriorly and then drops abruptly to level of exposed tips of

genitalia; width from above averages .75 mm. and depth from the side .94 mm.; exposed tip of dorsal valves short; averages .12 mm. in length; scaling on lateral aspect of 6th segment covers about one-half of segment. Genitalia averages 1.5 mm. in length and .55 mm. in height; practically no dorsal extension of valves anteriorly; dorsal valves from the side wide for horizontal length, averaging .27 mm. and from a dorsal view widely spread; angle formed by the horizontal and tangent lines—23 degrees; arch of the stylets in a horizontal plane rather than a vertical plane. Legs with the coxae black; black on all femurs; covers all but lemon yellow outer tip on hind-femurs; most of mid-femurs also and flares up on front-femurs to cover three-fourths or more; black on all tibiae becoming progressively greater in amount from front to rear. Thorax with the tegulae brown. Propodeum with a shallow median depression divided down middle by a central ridge which plays out halfway down; below central ridge are usually two rectangular areas separated by horizontal ridges; at top on either side of central ridge are two oval shiny areas; at base of median depression is a deep rectangular pit; dorsal part of whole median depression more depressed than ventral part. Antennae with the scape all black; joints tend to appear moniliform. Wings average in length 2.7 mm.; veins light lemon yellow; postmarginal vein less than one-half length of marginal; postmarginal averages .17 mm. (range .15–.20 mm.) and marginal .39 mm. (range .35–.42 mm.); stigmal club rectangular and tends to be flat basally. Wing-body ratio 1.18.

Male.—Length 2.5 mm.; wing veins heavy and dark brown in color.

Types.—5 females and 1 male; holotype female and allotype male along with paratype females in Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Querétaro, 28 miles north, State of Querétaro, Mexico; elevation 7300 feet; galls collected on January 17, 1932; males and females emerged on July 25, 1932.

Host.—Labels read, from galls of an undescribed species of the *Disholcaspis fungiformis* complex, Kinsey det., on *Quercus chihuanuensis*, Kinsey coll.

Range.—Known only from the type locality.

This species approaches the four preceding species in several characteristics: (length of the marginal and postmarginal veins, wing-body ratio, propodeal sculpturing, size and general proportions). It can be separated from them by its quite differently shaped genitalia, which shows practically no dorsal extension of the valves anteriorly, as well as the stoutness of the dorsal valves. In addition the presence of black infuscation on all femurs and tibiae of the legs will help to distinguish it.

On the basis of the distinct genitalia this species could be placed in a separate complex from the four preceding species. More material must be obtained and studied before its exact relationships can be determined.

Eurytoma spadix, n. sp.

Female.—Length 2 to 4 mm.; average 3.7 mm. Abdomen deeply oval to triangular from a lateral view; considerable dorsal arching

of the anterior part of the abdomen; depth from the side averages 1.2 mm.; width from above .85 mm.; fine scaling on lateral aspect of segment 6 covers one-half to three-fourths of surface; tips of ventral valves yellowish brown; tip of dorsal valves short and stubby. Genitalia averages 2. mm. in length and 1.4 mm. in height; dorsal valves wide for horizontal length, averaging .32 mm., and they turn abruptly dorsally, anteriorly; ventral valves turn dorsally also and then tend to bend backwards as though coiling up on themselves; angle formed by horizontal and tangent lines—43 degrees; stylet arch in a vertical plane. Legs with the coxae black; except front-coxae which may show yellowish tinge on inner surface; femurs most often brown with outer tips becoming lemon yellow; if black infuscation is present at all it appears on middle of hind-femurs only; tarsi white. Tegulae brown. Propodeum with a median depression down middle of which runs a straight central ridge; small ridges radiate laterally from central ridge across median depression; between lateral ridges finely shagreened; at top of central ridge is a deep gently curved pit; below pit on each side of central ridge are two large smooth shallow depressions; at base of central ridge are two deep pits or foveae; whole median depression wider at top than at bottom. Antennae with the scape yellow for lower half; rest black. Wings average in length 3.1 mm. (range 2.9–3.6 mm.); veins dark brown to straw yellow; marginal slightly more than twice as long as the post-marginal; marginal averages in length .38 mm. and postmarginal .17 mm.; stigmal club rectangular with rounded base. Wing-body ratio of 1.2.

Male.—Length 2.5 to 3.5 mm.; average 3. mm. Legs with most femurs and tibiae deep reddish brown; in a few slight black infuscation may appear on hind-femurs, hind-tibiae or mid-tibiae; front-coxae in most specimens all yellow; in a few basal half may be black and rest yellow; mid and hind-coxae black. Wing veins dark brown.

Types.—11 females and 17 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Villa Campos, 21 miles south, State of Durango, Mexico; 6700 feet altitude; galls collected on October 30, 1931; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of *Disholcaspis* (*perniciosa*) *quadrata* (Kinsey MS.), Kinsey det., on *Quercus undata*, Kinsey coll.

Range.—Known only from Villa Campos in the Western Sierra of Mexico.

This species is closely related to the next species (*E. venula*) from Canatlan, which lies to the south of Villa Campos. Both were bred from galls of the species of the genus *Disholcaspis* which occurred on the same oak host (*Quercus undata*). The two species of *Eurytoma* are about the same in average length and proportions, color of the legs and in the shape and sculpturing of the propodeum. On such a basis they could be placed in a distinct complex apart from the other species described herein.

The two species concerned here (*E. spadix* and *E. venula*) are easily

separated from one another by the following characteristics: shorter marginal vein in *E. spadix*; the fact that in *E. venula* the marginal is more than three times as long as the postmarginal, while in *E. spadix* the marginal is about twice as long as the postmarginal; the total lack of any black infuscation on any of the legs and the shorter less dorsally produced genitalia in *E. venula*. If males are available the yellow fore-coxae of *E. spadix* males in contrast to the black fore-coxae of the males of *E. venula* is a good characteristic.

Here, as in the group of five species preceding, we find that although *E. spadix* and *E. venula* are closely related structurally and occur in neighboring territories they were, nevertheless, bred from host species of different complexes, i.e., the *perniciosa* and *sulcatus* complexes. This is true of this whole group of new species as mentioned in the introduction. Apparently close correlation with the host does not go beyond the genus.

Eurytoma venula, n. sp.

(Plate I, fig. 7)

Female.—Length, 3.2 to 4.2 mm.; average 3.7 mm. Abdomen oval to rectilinear in shape from the side; scaling on lateral aspect of segment 6 covers about lower half of surface; anterior part of the abdomen extended dorsally more than in other species of this genus with the exception of *E. spadix*; depth averages 1.1 mm. and width from above .9 mm.; tip of dorsal valves short and stubby. Genitalia averages in length 1.7 mm. and in height 1.2 mm.; both dorsal and ventral valves turn dorsally but ventral valves do not tend to coil up on themselves; dorsal valves narrow (average .15 mm.) for horizontal length; angle formed by horizontal and tangent lines—42 degrees; stylet arch oblique. Legs with the coxae black; all femurs deep reddish brown in middle shading to lemon yellow tips; same is true for the tibiae; no black infuscation appears at all. Propodeum with a narrow median depression which is slightly wider at top than bottom; central ridge down center of depression from which radiate small lateral ridges dividing depression into series of small squares on each side of central ridge; at top of depression on each side of central ridge are two large oval areas; at base of depression are two triangular pits. Antennae with the scape yellow on lower half; rest black. Wings average in length 2.8 mm.; veins brown; marginal vein very long in relation to the postmarginal; actually marginal more than three times length of postmarginal; marginal averages .47 mm. (range .45–.50 mm.) and postmarginal .15 mm. (range .12–.17 mm.) in length; stigmal club rectangular to almost square and rounded basally. Wing-body ratio of 1.30.

Male.—Length, 2.1 to 3.2 mm.; average 2.8 mm. Legs with the coxae black; black infuscation on middle of hind-femurs; tips lemon yellow; other femurs mostly all yellowish brown; tibiae yellow brown except hind-tibiae which may show a slight trace of black medially.

Types.—5 females and 5 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Canatlan, 7 miles north, State of Durango, Mexico; elevation 7400 feet; galls collected on November 9, 1931; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of an undescribed species of the *Disholcaspis sulcatus* complex, Kinsey det., on *Quercus undata*, Kinsey coll.

Range.—Known only from Canatlan in the Western Sierra of the State of Durango.

E. venula has its closest relative in *E. spadix*. The similarities and differences between the species are listed under the description of *E. spadix*.

Eurytoma subfusca, n. sp.

(Plate I, fig. 8)

Female.—Length ranges from 2.6 to 3.6 mm.; average 2.9 mm. Abdomen globular in outline from the side; quite plump; depth from the side averages 1.1 mm. (range 1–1.2 mm.); width from above .85 mm. (range .80–1 mm.); white pile on segments 7, 8, and 9 quite sparse and short; lateral surface of segment 6 heavily scaled or pitted; covers about three-fourths of whole surface; exposed tip of dorsal valves very short and blunt; genitalia averages in length 1.3 mm. (range 1.3–1.4 mm.) and in height .80 mm.; ventral valves turn dorsally and are wide and stout for horizontal length, averaging .22 mm.; angle formed by horizontal and tangent lines—32 degrees; whole structure appears weak and widely spread from a dorsal view. Legs with the coxae black; rest of legs with a basic color of yellowish brown; black infuscation appears as a spot, medially, on outer face of hind-femurs and occasionally on hind-tibiae; no black on fore and mid-legs; tarsi white. Thorax with the tegulae brown. Propodeum with a narrow median depression divided by a central ridge for whole length; small lateral ridges extend from central ridge across depression to ridges bounding depression; at top of median depression are two large, shiny concavities, above these a narrow crescentic pit; below median depression is a deep, very distinct rectangular pit; median depression slightly wider at top than at bottom. Eyes, from a view of the head from above, are slightly bulgy behind. Antennae with the anterior face of the scape yellow on lower half only; rest black; pedicle small and round and may be dark brown to black. Wings average in length 2.6 mm. (range 2.5–2.7 mm.); veins lemon yellow; postmarginal averages .21 mm. (range .20–.25 mm.) in length and the marginal .35 mm. (range .30–.42 mm.); thus the postmarginal is more than half as long as the marginal; stigmal club quite deeply rounded basally which causes it to appear almost square. Wing-body ratio of 1.11.

Male.—Length ranges from 2.5 to 3.3 mm.; average 2.9 mm. Wing veins dark brown in color; more black on hind-femurs than in females.

Types.—29 females and 23 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, San Buenaventura, 3 miles east, State of Chihuahua, Mexico; 5600 feet altitude; galls collected on October 16, 1931; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of an undescribed species of the *Disholcaspis globulus* complex, Kinsey det., on *Quercus chihuanuensis*, Kinsey coll.

Range.—Known only from the type locality, but it very likely ranges north and south of San Buenaventura along the mountain range.

This species stands out as quite distinct from any of the others so far described. The more globular, plumper abdomen, differently shaped genitalia, and longer postmarginal vein in relation to the marginal will differentiate it from the others. Just what its relationships are cannot be stated at this time. Very likely it belongs to a distinct complex from any of the others but the exact nature of its position within the Breviura group will have to wait until more material is available from Mexico.

Eurytoma excellens, n. sp.

(Plate I, figs. 4 and 9)

Female.—Length, 2.6 to 3.7 mm.; average 3.1 mm. Abdomen conic ovate in outline from the side; considerable lateral compression; a few short white hairs on lateral aspect of segment 6; width of abdomen from above .70 mm. (range .65–.85 mm.); depth from the side 1 mm. (range 1–1.2 mm.); scaling on lower lateral aspect of segment 6 covers about half of surface; exposed tip of dorsal valves longer and more pointed, averaging about .20 mm. (range .17–.26 mm.) in length than in other species of this group; exposed tip of dorsal valves and of ovipositor sheaths stick upward at an angle of 45 degrees or more in relation to horizontal axis of abdomen; segment 6 about equal in width at widest point to width of segments 4 and 5 combined at their widest point; front part of abdomen with considerable dorsal extension. Genitalia averages in length 1.6 mm. and in height 1.3 mm.; dorsal valves narrow for horizontal length (averaging .15 mm.) and at anterior end turn dorsally and slightly posteriorly; ventral valves turn dorsally also and then bend posteriorly on themselves; angle formed by horizontal and tangent lines—54 degrees; stylet arch in a vertical plane. Legs with the coxae black; basic color of legs reddish brown; black infuscation may be present on fore and hind-femurs and all tibiae; never seems to be present on mid-femurs; tarsi white. Tegulae reddish brown. Propodeum with a short and broad median depression; central ridge runs down middle of depression from which emanate 4 to 5 distinct lateral ridges that connect with sharply defined ridges that outline median depression; whole depression wider at top than at bottom and wider than any other species of this group; at top of depression is a rectangular pit and at bottom a very shallow one. Antennae filiform with the basal half of the scape yellow; rest black. Wings average in length 2.6 mm. (range 2.4–2.8 mm.); veins reddish yellow to deep brown; marginal vein averages .33 mm. (range .27–.45 mm.) and the postmarginal .21 mm. (range .17–.27 mm.) in length; thus the postmarginal

is more than half the length of the marginal; stigmal club rectangular and gently rounded basally. Wing-body ratio of 1.20.

Male.—Length varies from 2.1 to 3.0 mm.; average 2.6 mm. Too poor for further description.

Types.—14 females and 3 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Aquascalientes, 35 miles east, State of Jalisco, Mexico; elevation 7000 feet; galls collected on November 28, 1931; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of an undescribed species of the *Disholcaspis fungiformis* complex, Kinsey det., on *Quercus undata* Kinsey coll.

Range.—Known only from the vicinity of the type locality.

This species, like the preceding one, is different enough from any of the others to suggest that it probably represents a distinct complex of its own. It may be separated from the other species by its differently shaped abdomen, genitalia, depression on the propodeum, and the relation of the length of the marginal and postmarginal veins.

AUREATA GROUP

PART IV

(Map No. 2 and Text figures 10 and 11)

The Aureata group includes *E. tepicensis* Ashmead (1895) and two new species described below.

Species of the Aureata group may be told from those of the Breviura, Mucronura and Atrateges groups by the plumper abdomen; very short, stubby, exposed tip of the dorsal valves; and almost total absence of black infuscation on the legs which are all yellow or brown including fore and mid-coxae. The different host relationships can also be used.

The Aureata group appears to be closest in its structural characteristics to the Breviura group. This is suggested by similar sculpturing of the propodeum; relationship of the length of the marginal and postmarginal veins of the fore-wing, and the general proportions of the genitalia.

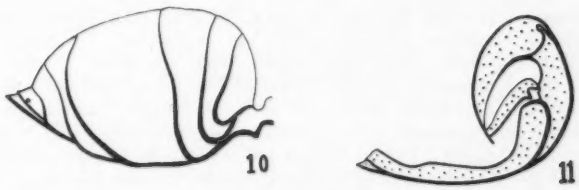
The species of this group, when all their host relationships are known, will probably be found to be restricted to the host genus, *Andricus* (*Cynipidae*).

Eurytoma aureata, n. sp.

(Map No. 2)

Female.—Length ranges from 2.7 to 3.9 mm.; average 3.3 mm. Abdomen circular in outline from the side; plump; depth averages 1 mm. (range .95–1.2 mm.) and width from above .75 mm. (range .60–.85 mm.); exposed tips of the dorsal valves very short and stubby and they barely project beyond the end of the abdomen; average about .09 mm. or less (range .07–.10 mm.) in length; fine scaling

on lateral aspect of segment 6 covers about two-thirds to three-fourths of surface; plays out dorsally. Genitalia averages 1.3 mm. (range 1.1–1.5 mm.) in length and 1.0 mm. (range .85–1.1 mm.) in height; dorsal valves thin for horizontal length (average .11 mm.; range .07–.15 mm.) and turn dorsally, anteriorly; ventral valves turn dorsally also but not backwards; angle formed by tangent and horizontal lines—45 degrees; stylet arch approaches close to a vertical plane. Legs with the front-coxae yellow along inner margins and in a few with a yellow tinge to the mid-coxae; basic color of femurs and tibiae yellow to reddish-brown; slight black infuscation, when present at all, on hind-femurs only; tarsi white. Tegulae brown. Propodeum with a shallow median depression, wider at top than at bottom; divided by a fine central ridge that plays out basally; below base of median depression is a shallow rectangular pit that often appears divided by a median ridge; areas lateral to median depression shagreened. Eyes, from above, bulge laterally; no noticeable round pit below eye. Antennae clavate with the outer face of scape yellow in most; pedicle dark brown in some specimens; rest black; club,



TEXT FIGURES 10 AND 11

Genitalia and Abdomen of a New Species of the genus *Eurytoma* from Mexico (Aureata Group):

FIG. 10. Female abdomen of *Eurytoma numerosa*. 11. Female genitalia of *Eurytoma numerosa*.

especially tip, may be dark brown in some. Wings with the veins straw yellow; not heavy; marginal vein averages .36 mm. and the postmarginal vein .18 mm. in length; stigmal club rectangular and gently rounded basally. Wing-body ratio of 1.22.

Male.—Length, 2.7 to 4.2 mm.; average 3.5 mm. Legs with both fore and mid-coxae yellow; hind-coxae black; rest of legs all yellow to yellowish-brown; slight black infuscation appears medially on hind-femurs in only a few; wing veins heavy and yellowish-brown; gold tinge to pile covering face and thorax. Outer face of scape yellow for whole length.

Types.—53 females and 20 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, Rio Verde, 14 miles west, State of San Luis Potosí, Mexico; elevation 6000 feet; galls collected on December 4, 1931; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of an undescribed species of the *Andricus aciculatus* complex, Kinsey det., on *Quercus polymorpha*, Kinsey coll.

Range.—Known only from the type locality but probably covering the mountain ranges in the vicinity of Rio Verde.

This species and the next one are very closely related. Upon a superficial acquaintance they are very hard to separate, but on careful study they may be differentiated on the basis of the following characteristics: *E. aureata* averages slightly larger than *E. numerosa* and this is carried over into the relation of the length of the marginal and postmarginal veins; in *E. aureata* both veins average longer than in *E. numerosa*; the stigmal club in this species is gently rounded basally while in *E. numerosa* it is flat or triangular basally; *E. aureata* has more yellow on the front and mid-coxae of both males and females, as well as on the scape of the antennae. The different host relationships and distribution will also aid in separating them.

Eurytoma numerosa, n. sp.

(Map No. 2; Text figures 10 and 11)

Female.—Length, 2.5 to 3.5 mm.; average 3.1 mm. Abdomen circular in outline, plump; width is equal to .75 mm. (range .70–.85 mm.) from above and depth, from the side, 1. mm. (range 1.–1.2 mm.); exposed posterior tips of the dorsal valves very short and stubby, averaging about .07 mm. in length; lateral surface of segment 6 finely scaled; covers about one-half to two-thirds of surface. Genitalia averages 1.1 mm. (range 1–1.2 mm.) in height and 1.4 mm. (range 1.2–1.5 mm.) in length; dorsal valves thin for horizontal length (average .10 mm.; range .07–.12 mm.); turn dorsally anteriorly at right angles; ventral valves turn dorsally also and very slightly posteriorly; angle formed by tangent and horizontal lines—50 degrees; stylet arch in a vertical plane or very nearly so. Legs with tinge of yellow toward median edge of fore-coxae; rest of coxae black; reddish-brown femurs in most cases with no black infuscation medially; in a few black may appear on hind and mid-femurs; tibiae usually all reddish-brown with tips lemon yellow; slight black infuscation on mid-tibiae of a very few. Tegulae brown. Propodeum with a shallow median depression which is wider at the top than bottom; central ridge divides depression into two halves for about half its length in most; in a few may continue to base of depression; at base of depression is a rectangular pit; small lateral ridges cross from median ridge to boundaries of depression dividing areas up into small squares or rectangles; lateral to median depression, areas finely shagreened. Eyes, from above, bulgy laterally; fine, round, shallow pit below eye. Scape of antennae all yellow. Wings with the veins reddish-brown; marginal vein averages .33 mm. and postmarginal .15 mm. in length; stigmal club either rectangular or bottom deeply triangular in outline. Wing-body ratio of 1.24.

Male.—Length ranges from 2.2 to 3.5 mm.; average 2.9 mm. Legs with the front-coxae all yellow; mid-coxae may be all yellow or show only a tinge of yellow; black or dark brown infuscation may

appear on hind-femurs and tibiae and mid-tibiae in majority; a few show all yellow legs. Scape with upper one-fourth to one-half black on outer face; rest yellow in majority.

Types.—33 females and 16 males; holotype female and allotype male along with paratypes of both sexes in the Bugbee collection, Hays, Kansas.

Type Locality.—Labels read, C. Victoria, 21 miles west, State of Tamaulipas, Mexico; elevation 3200 feet; galls collected on January 21, 1932; males and females emerged in the spring of 1932.

Host.—Labels read, from galls of an undescribed species related to *Andricus furnessae* Weld, Kinsey det., on *Quercus polymorpha*, Kinsey coll.

Range.—Probably extending over a considerable area of the mountain ranges north, south and west of C. Victoria.

E. numerosa is closely related to the preceding species (*E. aureata*). Their differences and similarities are pointed out under the description of *E. aureata*.

Eurytoma tepicensis Ashmead

E. tepicensis Ashmead. Proc. Calif. Acad. Sci. 5: 551, 1895.
E. tepicensis Bugbee. Jour. Kans. Ent. Soc. 14(2): 56, 1941.

The following description of *E. tepicensis* is that of Ashmead: Length 2.2 mm.; black; scape and legs, except coxae and the hind femora medially brownish-yellow; tegulae black; wings hyaline, the veins brownish-yellow.

Head and Thorax: Flagellum, legs and apex of abdomen, clothed with a sparse, glittering, white pubescence. The flagellum is not quite three times as long as the scape, the pedicel is half as long as the first joint of funicle, very little longer than thick at apex; funicle 5-jointed, without counting the single ring-joint; the first joint being the longest, or fully twice as long as thick, the following very slightly decreasing in length so that the fifth joint is only slightly longer than thick; club 3-jointed, a little shorter than the scape. The pronotum seen from above is almost as long as the mesonotum, the scutellum to its tip being considerably longer than the mesonotum; metanotum medially, sulcate, the sulcus having two delicate parallel carinae, the space between them being filled with delicate transverse raised lines. Marginal vein of front wings rather stout, one and one-half times as long as the stigmal, the latter being a little shorter than the postmarginal.

Abdomen subsessile, not longer than the thorax, blunt at the apex, the 5th segment the largest, about two and one-half times as long as the 4th, the 6th about half the length of the 4th, the 7th a little longer than the 6th, bearded with white hairs and bearing spiracles, the 8th segment retracted.

Type.—Described from one female specimen located in the collection of the California Academy of Sciences, San Francisco, California.

Type Locality.—Tepic, Mexico, State of Nayarit.

Host.—Unknown.

Mr. C. D. Michener of the University of California, who compared specimens representing the Atrateges group with the single female type of *E. tepicensis*, described Ashmead's species by letter as follows:

"Abdomen, areas on sides of thorax, and coxae dark brown; tegulae shining brown; apex of abdomen not nearly so produced as in your specimens (*refers to specimens belonging to Atrateges group*); abdomen impunctate, strongly shining, and much less compressed than in Atrateges; trochanters, femora, tibiae, and tarsi yellow, posterior femora brown medially (no black infuscation); wing veins whitish, vein 'a' (*postmarginal*) noticeably shorter than 'b' (*marginal*)." Italics mine.

It is obvious, from a comparison of the two descriptions, that they do not jibe at several points. Ashmead described the tegulae as "black" while Michener describes them as "shining brown"; Ashmead implies that the coxae are not yellow, but black, while Michener describes them as "dark brown," etc. This apparent disagreement appears to be another case in which Ashmead may have described a species as *E. tepicensis* from one specimen and attached the label of some other specimen. Or he may have used two different insects for one description as Michener believes he did in a case among the bees. Quoting from a letter from Michener, he says, "In one case, he (Ashmead) almost certainly described the head and thorax of one bee, then went out and upon returning picked up another species for the description of the abdomen."

More recently Dr. E. Gorton Linsley compared specimens of *E. aureata* and *E. numerosa* with the type of *E. tepicensis* and in a letter states, "I would say that in general this species (*E. tepicensis*) agrees pretty well with your description of the Aureata Group."

Thus *E. tepicensis* differs from *E. aureata* and *E. numerosa* in the presence of "dark brown" color on the abdomen and sides of the thorax and the "impunctate" sides of the abdomen. It agrees with the species of the Aureata Group as follows: The short, stubby ends of the dorsal valves; dark brown to yellow-brown tegulae and coxae; yellow legs; lack of black infuscation on femurs and tibiae and the relation of the length of the marginal and post-marginal veins.

Until more material from the same locality can be studied, *E. tepicensis* is placed in the Aureata Group, where it would seem to fit into a complex of its own (Tepicensis complex as distinct from the Aureata complex).

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THE NESTING HABITS OF THE WASP, CHLORION (AMMOBIA) PENNSYLVANICUM L.[1]

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This wasp, the "Great Black Wasp" of John Bartram, is of historic interest, for it was the first solitary digger wasp to be described from this country; an account of the behavior of the Great Black Wasp from Pennsylvania was communicated by Mr. John Bartram to Mr. Peter Collinson and read before the Royal Society on December 21, 1749.[2]

Despite the implications of its name, this wasp is found to be fairly abundant in the Missouri valley. Here, for a number of years, I have found them on flowers, but I had never seen them in the act of nest-making until I was led by an observing friend to see a colony in 1938.

With amazement, I viewed a large aggregation of these wasps nesting in the ground at the home of Mr. Shepherd at Pacific, Missouri. These activities were not being carried on in the open sunshine, as is the custom of sister species, but in the subdued light of an abandoned tool-house, where they came and went through the broken window panes as they dug their burrows in the soft dirt floor. It seems to be the habit of these wasps to nest in sheltered places, for Rheinhardt also found them nesting in a similar shelter.

In the earthen floor of this tool-house, on September 4, were twenty open burrows, each with its mound of excavated dirt beside it, and each with a mother wasp either carrying out more dirt or bringing in prey as provender for her young. This dirt floor, seldom trodden upon by man, was soft, and afforded easy digging for the wasps. The uniformly soft soil here, without debris or stones, made excavating an easy task for them.

In digging, the mothers would bite out the soil, load it on the partly outstretched front legs, hold it in place with their jaws, walk out of the burrow backwards and drop the load on a neat pile at one side of the hole. When the pile had become too high, and there was danger of the dirt falling back into the burrow, she would scatter the subsequent loads to the winds by very rapid brushing movements of the front legs. The nests were so close to one another that it often happened that a busy mother would break through the thin wall into a completed nest, and presently bring up and throw away a good cocoon containing a neighbor's offspring.

One nest which I excavated measured an inch in diameter at the opening, went down diagonally at an angle of 45 degrees for five inches, then turned backwards and continued horizontally for two inches, and finally terminated in a pocket one and one-half inches long by one-quarter inch in height. This pocket contained five adult katydids, all of the species *Phaneroptera furcata* Brunner [A. B. Gurney], one

[1]Species identified by the late Grace A. Sandhouse.

[2]E. G. Rheinhardt, The Witchery of Wasps, pp. 165-176, 1929.

of which bore an egg on the under side of the abdomen.[3] The katydids showed only the faintest trace of life, and that only when stimulated. Even though the prey was as large as the wasp, the latter had no difficulty in transporting them through the air, flying gracefully and swiftly through the open window and placing the prey at the opening of the nest; there they left them for a few seconds while they made a final inspection of the burrow, and finally emerged as far as the threshold and pulled the prey into the hole.

The season for the adult life of this species is evidently long, for they were at work in early September, and a cocoon which I excavated at that time gave forth an adult male on June 19, 1939. The indications are, therefore, that the length of life of the adult is a little more than three months. It seems probable that the males are shorter lived, because none were seen in the busy colony the first week of September.

The consensus of reports indicates that this species requires for its nesting purposes soft earth and adequate shelter, for Rheinhardt likewise found a large colony of them in the same kind of situation, the soft earth in an unused greenhouse, where they had access through broken windows and open door. Bequaert also found a sister species, ***Chlorion (Ammobia) caliginosum***, in Colombia,[4] also a hunter of longhorned grasshoppers, likewise excavating nests in the floor of an abandoned building, this time an old church, and coming and going through the open windows. They seem to feel an urge to seek overhead protection, for several of those in the tool-house had chosen nesting-sites under overturned tubs or boxes. I wonder if this species ever nests in the open fields, as do other species of the genus *Chlorion*. Possibly an answer to this question lies in the aforesaid observation, for if they seek sheltered places in the fields as they do here, they would seldom be found.

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[3]Reinhardt observed the species stocking the nests with *Microcentrum laurifolium* and *Scudderia furcata*.

[4]Bull. Brooklyn Ent. Society, 32: 186, 1937.

THE BIOTIC PROVINCES OF NORTH AMERICA, by LEE R. DICE. viii+ 78 pp., 1 map. University of Michigan Press, Ann Arbor, Michigan, 1943. Price $1.75.

When a book so arouses my interest within a few pages that I want to read the rest, I regard it as a good book. This one has done more. Its logical evaluation of data has not only aroused interest but has also left a feeling of confidence in the practical value of its biotic provinces for other fields of biology. And after reading I was not contented until I had subjected some of my taxonomic problems to the test of Dice's biogeographical findings. The results were several: They confirmed the author's emphasis on plant life as the chief basis of the provinces, stated on page 5, and the continuing statement on page 6 concerning the imperfect correlation between plant and animal distribution at the boundaries of the provinces. Nevertheless the bearing of his findings on the difficult taxonomic distinction involved was so helpful that it implies high value for this work as an adjunct of taxonomy and strongly suggests that it must be an important contribution in its own special field.—A. W. L.

ILEAL CAECA IN THE EUMASTACIDAE (ORTHOPTERA)

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Iowa City, Iowa

In one of several papers on the internal genitalia of female Orthoptera it was noted that those species which belonged to the family Eumastacidae each had six well-developed, fingerlike diverticula or caeca attached to the hindgut not far from its anterior end (Slifer, 1943). Approximately 340 species of Orthoptera, distributed through four related families (Tetrigidae, Eumastacidae, Proscopiidae and Acrididae), were examined in this series of studies on the genitalia and since caeca were found on the hindgut in none except members of the Eumastacidae their presence in this one group would seem to deserve closer attention.

The number of species on which this report is based is small, but since the individuals were collected in widely-separated localities (Africa, Java, North America and South America) it is not unlikely that the results secured with them will be found to apply to other Eumastacidae as well.

MATERIALS AND METHODS

The following members of the Eumastacidae were examined:

Erianthus guttatus Westwood.
Erucius sp.
Eumastax surinama Burr.
Gymnotettix lithocolletus Rehn and Rehn.
Malagassa sp.

The first and last three species listed above were available only as dried, pinned museum specimens. The abdomen of each of these was treated with a hot solution of potassium hydroxide and then dissected. Since the ileal caeca are lined with a chitinous intima—as is the rest of the hindgut—they can be identified readily in such preparations even though all of the cellular parts have been destroyed.

About a dozen preserved specimens of Erucius sp. were sent to the writer by Dr. E. R. Helwig. These consisted of adults and last instar nymphs which had been carefully fixed so that the internal organs were in excellent condition for histological study as well as for dissection. Both cross and longitudinal sections of the alimentary canal were made and stained either with Heidenhain's hematoxylin or with Mallory's triple connective tissue stain. The latter proved especially helpful in bringing out more clearly the basement membrane and the limits of the chitinous lining of the hindgut.

[1]The author wishes to thank Dr. B. P. Uvarov, of the British Museum, Mr. J. A. G. Rehn, of the Academy of Natural Science in Philadelphia, and Dr. E. R. Helwig, of the University of Pennsylvania, for generously contributing the material for this study. Dr. T. N. Tahmisian of this department made the photomicrograph shown in figure 2.

Alimentary canal.—The alimentary canal of Erucius sp. is in no way unusual except for the presence of caeca on the hindgut. The foregut needs no special mention and, as may be seen in figure 1, the midgut is provided with six gastric caeca which are not markedly different from those found in the Acrididae. The hindgut is divided into three distinct regions—ileum, colon and rectum—and of these only the first will be discussed here.

The ileal caeca.—Twelve groups of Malpighian tubules enter the anterior end of the ileum. Six of these groups contain about 14 or 15 tubules each and the remaining six only one or two tubules each. The large and small groups are arranged alternately around the ileum. The total number of tubules, then, is not far from one hundred. The tubules of each group enter a small sac or ampulla which, in turn, opens into the hindgut (AMT, figs. 1, 7). From the posterior region of each of the ampullae which are associated with the large groups of tubules—but not from the small ones—an excretory furrow (EF, figs. 4, 5, 7) passes

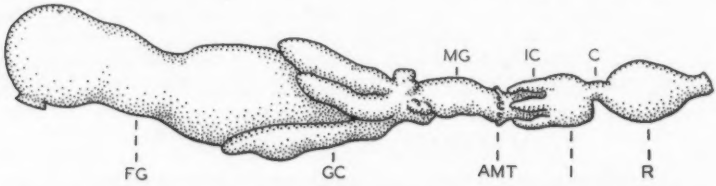

FIGURE 1. Alimentary canal of adult female *Erucius* sp., Malpighian tubules omitted, except for ampullae. AMT, ampullae of Malpighian tubules; C, colon; FG, foregut; GC, gastric caeca; I, ileum; IC, ileal caeca; MG, midgut; R, rectum. ×8.

back along the lining of the ileum. Posteriorly each of these six excretory furrows turns forward into one of the ileal caeca and ends close to its anterior tip. These furrows are open for their full length to the lumen of the ileum and to the cavities of the ileal caeca as well but their structure is such that when the walls of the ileum are constricted by the extremely heavy muscular layers on their outer surface (CM, LM, M, figs. 4, 7) these furrows must, for all practical purposes, serve as closed canals. In the caeca, however, they would probably remain open for the muscular layers here are poorly developed. Posteriorly the caeca open directly into the ileum.

Histological structure.—Histologically the most conspicuous feature of the ileal caeca is the single layer of large epithelial cells (E, fig. 3). These are provided along their outer border with a delicate basement membrane (BM) and their inner edges are covered with a rather thin chitinous cuticle or intima (C). Just beneath the cuticle the cytoplasm of the epithelial cells shows a well-developed striated border (SB) suggestive of that commonly found in the epithelial cells of the midgut and Malpighian tubules of insects. Externally each caecum is supplied with a half dozen or so widely-separated, narrow, longitudinal muscles (LM). These meet near the tip of the caecum. Running at right

angles to these muscles, and between them and the basement membrane, are inconspicuous, scattered groups of circular muscles (CM). A comparison of the walls of the caeca with that of the ileum itself brings out several differences: *first*, the chitinous intima in the caeca is much thinner than it is in the ileum; *second*, the epithelial cells in the caeca are larger than are those in the ileum; and *third*, the muscular layers of the caeca are much less conspicuous than are those of the anterior part of the ileum. The muscles of the caeca more nearly resemble those of the posterior part of the ileum.

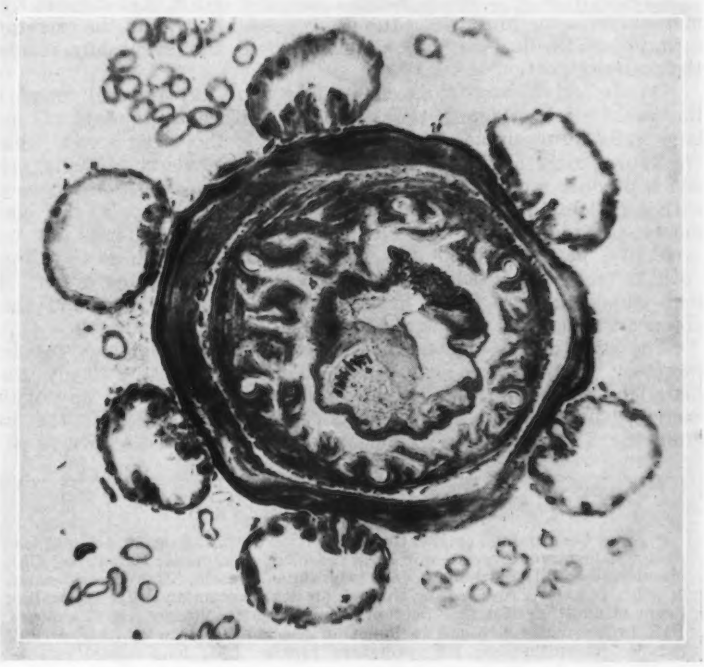

FIGURE 2. Cross section through alimentary canal of adult female *Erucius* sp. in region of ileal caeca. × 90.

Function of ileal caeca.—The ileal caeca in some specimens of Erucius sp. were either empty or else contained traces of a fine granular coagulum; in others the caecal cavities were filled or partially filled with a compact brown mass (BM, fig. 4). In sections this appeared as an amorphous material, occasionally vacuolate, composed of blobs and granules of variable size. Little could be determined concerning the nature of this material except that it is, after fixation, not dissolved by the various agents used in making paraffin sections. In preparations treated with Mallory's connective tissue stain it is a greenish-blue.

In some animals a brown substance similar to that in the caeca was found also in the ileum posterior to the caecal openings and outside the peritrophic membrane, which envelops the food residue in the intestine. This, of course, is to be expected for the posterior ends of the caeca open widely to the ileum (O, figs. 6, 7). It may be assumed, then, that the contents of the caeca are passed into the ileum.

The source of the caecal contents is more difficult to determine. Traces of a brown material similar to that described above were found in the excretory furrows both in the caeca and in the ileum and, in one case, a little of it was seen in the ampullae of the Malpighian tubules. The evidence here is by no means conclusive but it does suggest that material from the Malpighian tubules is passed by way of the excretory furrows into the ileal caeca, accumulates there, and, eventually, reaches the posterior portion of the ileum.

On the other hand it is conceivable that the material found in the caeca may originate there for the epithelium consists of very large cells quite similar to those in other orthopteran organs which are known to be secretory in nature. However, insect epithelial cells which produce secretions and which, at the same time, are covered with a cuticle through which these secretions must pass, are commonly provided with minute, chitinous canaliculi. These, at one extremity, penetrate deep into the epithelial cells and, at the other, open through the cuticle into the lumen of the secreting organ. No such canaliculi were found in the eumastacid ileal caeca and their absence would argue against a secretory function for these parts.

The structure as well as the relationships of Malpighian tubules, excretory furrows and ileal caeca, then, all suggest strongly that materials originating in the tubules pass into the caeca by way of the excretory furrows and from there later reach the ileum. In the diagram (fig. 7) the ampulla of the Malpighian tubules is shown as if it

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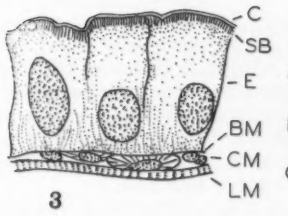
EXPLANATION OF FIGURES 3 TO 7

Fig. 3. Longitudinal section through portion of wall of ileal caecum of last nymphal instar of *Erucius* sp. BM, basement membrane; C, cuticle; CM, circular muscle; E, epithelium; LM, longitudinal muscle; SB, striated border. × 365. FIG. 4. Cross section through an ileal caecum and adjacent wall of ileum of adult *Erucius* sp. Section passes close to anterior tip of caecum. BM, brown material found in lumen of caecum; C, cuticle; CM, circular muscle; E, epithelium; EF, excretory furrow; LM, longitudinal muscle. × 150. FIG. 5. Cross section through wall of caecum and adjacent wall of ileum. Same specimen as fig. 4. Section close to region where excretory furrow turns forward into caecum. C, cuticle; CM, circular muscle; E, epithelium; EF, excretory furrow. × 150. Fig. 6. Cross section through wall of ileal caecum and adjacent wall of ileum. Same specimen as fig. 4. Section close to posterior end of caecum. C, cuticle; E, epithelium; M, muscle; O, opening of caecum into ileum. × 150. FIG. 7. Diagram of longitudinal section through part of wall of alimentary canal of last instar nymph of *Erucius* sp. One side only of alimentary canal shown. No attempt has been made to represent the narrow longitudinal opening which extends the entire length of the excretory furrow and by means of which it communicates with the cavity of the ileum and of the ileal caecum. AMT, ampulla of Malpighian tubules; E, epithelium; EF, excretory furrow; I, ileum; IC, ileal caecum; M, muscle; MG, midgut; MT, Malpighian tubule; O, opening of caecum into ileum. × 70.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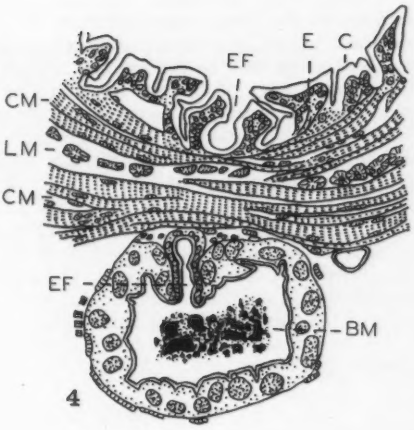
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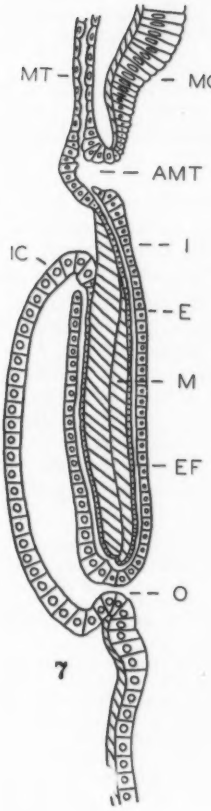
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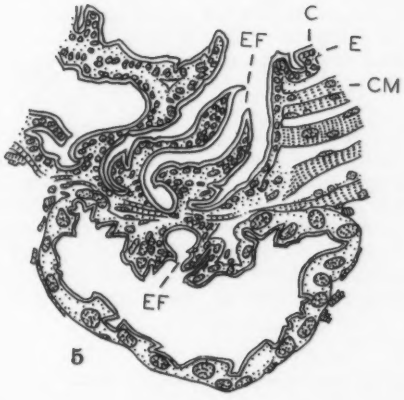
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6

were open to the intestine. In effect, however, this is not the case for portions of the ileal lining protrude anteriorly between the ampullae and then extend laterally in such a way as to block, more or less completely, the opening to the hindgut. Thus we might expect to find that that greater part of the products of the tubules drains into the ileal caeca but that some of it escapes into the anterior part of the ileum. In this connection it should be noted again that the six small groups of Malpighian tubules, which alternate with the large groups, have no excretory furrows of their own and, likewise, no ileal caeca. Presumably their secretions also go directly into the intestine.

It is impossible at this stage of our knowledge to draw any definite conclusions regarding the function of the ileal caeca. Perhaps they are a device for the conservation of water or some other substance lost through the Malpighian tubules. The extreme thinness of the cuticular lining of the caeca hints that this might be the case. But, until someone is able to examine the caeca in the living condition the problem will, most likely, remain unsolved.

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THE ANTS OF THE CHICAGO REGION[1]

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The area at the southern end of Lake Michigan is interesting ecologically for the transition between the deciduous forests and the "prairie wedge;" the latter reaches its most eastern extension in Indiana. There is also a well-marked transition between the boreal and the austral portions of the forested land, and semi-arid conditions prevail in the dune localities.

Numerous papers on the geological and ecological features of the region have been published (Salisbury and Alden, 1899; Fryxell, 1927; Cowles, 1899, 1901; Shelford, 1907, 1908, 1911, 1912, 1913; Fuller, 1914, 1925, 1934, 1935; Pepoon, 1927; Peattie, 1930; O. Park, 1930, 1931 a, b, 1935, 1937; Park, Lockett and Myers, 1931; Park and Keller, 1932, Park and Sejba, 1935; Park and Strohecker, 1936; Pearson, 1933; Talbot, 1934; Strohecker, 1937 a, b, 1938; Lowrie, 1942). In addition, studies on the biology of a local aggregation of *Formica ulkei* nests have been contributed (Holmquist, 1928; O. Park, 1929; T. Park, 1929; Dreyer and Park, 1932).

The materials for this report were accumulated while the author was engaged on another program, and are largely qualitative as no exact sampling methods were employed. Yet, to one collecting a specific group in a limited area the degrees of abundance soon become evident, and from such experience an indication of the relative numbers of each species is included in the table of habitat comparisons (Table I; see also Table III). The number of places actually visited is not large, but selected localities representing sixteen major habitats have been investigated repeatedly.[2]

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[1]The excellent study by Dr. Mary Talbot on adaptive differences among certain *Formicae* and the ecological distribution of ant species in the vicinity of Chicago, Illinois, has led the author to undertake similar field studies and to record the results with the view of adding new data for the region. It is hoped this report will be of aid to those wishing identification of the local ants.

[2]I wish to acknowledge indebtedness to the following persons whose help has been greatly appreciated. Dr. Talbot afforded much early assistance with the taxonomy of ants and the checking of determinations. Dr. Neal A. Weber has graciously supplied the names for certain species of *Myrmica*. Dr. Donald C. Lowrie, and others whose names appear in connection with the localities collected, have added many specimens. My sincere thanks are extended to the Department of Zoology for providing various facilities, and to my wife, Ella Virginia Gregg, I am especially grateful for aid in numerous instances and for many specimens. To Mr. R. W. Miller belongs the credit for preparation of the photographs.

THE CHICAGO REGION

Prairies lie west and southwest of Chicago, and ant mounds are everywhere visible although the number of species is low. Eight species are listed but only *Formica cinerea neocinerea* is abundant, and probably ninety-five per cent of the nests are constructed by this form. *Polygerus rufescens breviceps*, one of the rarest of ants, is present locally as a parasitic (dulotic) species on this vast assemblage of *cinerea* nests.

At the junction of prairie and forest a rich parkland and savanna is found, and this is shown by the interdigitation of grasslands on the upland with trees along the watercourses. Forest margin and meadow are important habitats and such ants as the yellow *Lasii*, *Formica ulkei* and *Formica sanguinea* can be expected to occur. It may be surmised that the total amount of forest-prairie ecotone is larger than formerly, and correlated with this may be an increase in the number of ant species. Certain inhabitants of the deep woods may be rarer than when climax forests were continuous. The ant, *Proceratium silaceum*, is probably an illustration of this tendency (Kennedy and Talbot, 1939).

On the terminal and ground moraines and outwash deposits to be seen at Palos Park, Orland Park, New Lenox, Volo, Aurora, Illinois, and Lake Geneva, Wisconsin, there are stands of oak forest. Black, red and white oaks are mixed in varying proportions, and the ants *Prenolepis imparis*, *Formica fusca subaenescens*, *F. f. subsericea* and *Lasius niger alienus americanus* are common members of the community. Along streams and ravines elm and hickory are added indicating more mesic conditions (e.g., at New Lenox, Mount Forest Island at Palos and at Hadley, Illinois), and the ant *Camponotus herculeanus pennsylvanicus ferrugineus* often makes its appearance in these situations.

The oak-hickory forest is perhaps the physiographic climax for some localities, but beech seems to be restricted to the more humid stations in northern Indiana and southern Michigan. This lake-border region marks a portion of the western boundary of the beech-maple-hemlock cover type, and stands of this climax were studied at Warren Woods (Lakeside), Michigan, and at Smith, Indiana, both on mixtures of silt and clay. The ants most strikingly associated with the beech-maple forest are the several species of the *Aphaenogaster fulva* complex, *Myrmecina graminicola americana* and *Leptothorax longispinosus*.

Floodplain forests on argillaceous substrata flank the numerous rivers, and collections were made in the Salt Creek Forest Preserve of Chicago (elm and oaks), and beside Coffee Creek near Chesterton, Indiana (elm-oak-maple-basswood). The ants of this community do not differ radically from those of the oak and oak-hickory types, but the single nest of *Strumigenys pergandei* was collected from a log in the Coffee Creek woods.

The area about the head of Lake Michigan originally was one of extensive marshes, but unfortunately, much of this land has been drained. In the marshes of the Palos hills, the temporary marshes of the low prairie southwest of Chicago and in the Lake Calumet district, the prairie ant, *Formica c. neocinerea*, is the most obvious resident.

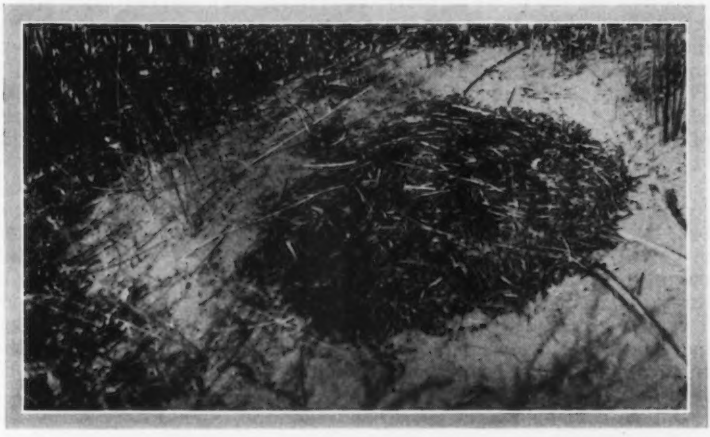

FIG. 1. Low, thatch covered mound of *Formica rufa aggerans* Wheeler in the dunes at Waukegan, Illinois. Photo by Zora Ivaska.

FIG. 2. Masonry dome of *Formica ulkei* Emery from the local aggregation of these ants at Palos Park, Illinois. Shows differential angles of slope oriented with reference to the sun; longest slope faces south. Photo by A. S. Windsor.

This may be due to its capacity for building high conical domes which could stand above the water during periodic inundation, but the author did not succeed in proving this supposition. In drier prairies, however, the mounds were much lower. In the senescent marshes of the Gary Pond Series at Hammond, Indiana, were found several nests of *Formica ulkei*, and even more astonishing were a number of large formicaries of *Lasius umbratus mixtus aphidicola* (see discussion of this species below).

Bogs are infrequent but one mid-stage tamarack bog in the lake region near Volo, Illinois, was visited several times and a senescent bog at Dune Acres, Indiana, on at least one occasion. The ant fauna of bogs is, as far as observed, rather meager, although from these the majority of *Dolichoderus* were taken. These ants nested between the leaves of dead *Typha* plants, and other species were in rotting wood. Two *Myrmicae* (*brevinodis* and *brevispinosa*) actually nested in the bog mat and could be located usually by standing at one place until the sphagnum sank causing the ants to retreat to the surface ahead of the rising water.

Three sandy areas in the Chicago Region, each with certain distinctive features, have been described at some length (Lowrie, 1942). The classical strip of dunes along the southern and eastern shore of Lake Michigan is the most diversified, and was examined at Pine, Miller, Ogden Dunes, Dune Acres (Mineral Springs), and Tremont, Indiana, and at Lakeside, Michigan. It includes substantial plant and animal successions which correlate with changing physiographic conditions progressing inland from the lake (Cowles, Shelford, O. Park, Strohecker). The typical sequence at Ogden presents three levels of beach (lower, middle and storm beach), foredunes (formed by sand-binding grasses, *Ammophila* and *Calamovilfa*), cottonwood dunes (height correlated with this species of tree), Jack and white pine pioneer woodlands or meadows of *Andropogon*, black oak woodlands and in sheltered pockets behind the high sand, mesophytic forests of red-white oak, maple, basswood, et cetera, which approach closely the beech-maple climax. Outstanding examples of ants which parallel this series are (1) *Monomorium minimum, Lasius niger neoniger* and *Pheidole bicarinata* on the upper beach and the two subsequent pioneer stages, (2) *Iridomyrmex pruinosus analis, Paratrechina parvula* and *Crematogaster lineolata* in the evergreen zone, (3) a long list of species of which the *Formica pallidefulva* group is almost diagnostic for the black oak woodland, and (4) a group of ants similar to those in the beech-maple forest with the conspicuous addition of *Lasius flavus nearcticus* and *Formica truncicola obscuriventris* in the mesophytic ravine subclimax. Some species range over two or more of the plant associes, but we can recognize the following trends. Representatives of the tropical and somewhat xerophilous genera *Monomorium* and *Pheidole* are the predominant species in the hot, semi-arid conditions of the open sand whether on the usual dune sequence or in stations where the plant cover has been removed and the dunes rejuvenated. Typical deciduous forest members increase directly with the increase of mesophytism, and an abrupt change of this sort is noted in passing from the pines into the oaks. The occasional presence of *pallidefulva* species in the pine

FIG. 3. Mixed oak forest and vernal pond at Palos Park, Illinois. Photo by Ecology Class, 1933.

FIG. 4. The Gary Ponds. View eastward from the embankment of the Elgin, Joliet and Eastern Railroad where it crosses Highway Twelve, showing the successional series of parallel ridges and depressions formed in Lake Chicago as sand bars and land-locked pools. Photo by Ecology Class, 1938.

woods may be an indication of environmental changes among the pines which culminate in their replacement by black oaks. Many of these tendencies are observable in Table I.

At Tremont the subclimax is well developed over much of the State Park, but the succession seems to be partially destroyed by an eroding shore which has reached far enough to expose some of the mesophytic forests on old established dunes. The lush growth ends sharply above steep, lakeward slopes with foredunes at the base. At Lakeside undercutting and slumping from wave action have produced high cliffs of sand which stand sixty to eighty feet above the water. The pattern in the Indiana dunes is further complicated by blowouts in which the terrestrial succession may start anew, and if the surface has been lowered beyond the water-table, pannes of open water and marshes develop.

Near Pine, Indiana, the ant species are identical with those in the pioneer stages of the other dune localities. The series of linear ponds alternating with former sand bars of Lake Chicago is still intact, but it is lamentable the first three or four of these have been filled by steel mill wastes. As previously noted, some of the oldest ponds which are now drying cattail swamps were visited at Hammond.

In the dunes of the Kankakee River basin ten miles south of Momence, Illinois, the ants are very similar to those of the other black oak forests on sand, but *Pheidole morrisi*, *Formica pallidefulva schaufussi* and *Formica sanguinea subintegra* are unusually abundant. The dunes are low and the vegetation consists of oak woods and meadows of mixed grasses.

Along the shore north of Waukegan, Illinois, the ants are again similar to those of the Indiana and Kankakee dunes except that *Formica neogagates* is considerably more abundant and the rare *Lasius latipes* was secured there. Almost all records of *Pheidole pilifera* were obtained from this station also. The vegetation is characterized by sand-binding grass, black oak ridges, Scotch pine and spreading marshes.

Within the various forest habitats are several strata, but only the subterranean and ground strata are important as places of abode for ants. They search in the trees for aphid honey-dew and capture much insect prey, but unlike tropical and subtropical species, seldom seem to build nests above the ground. Colonies either have galleries in the soil with craters or masonry domes at the surface, or are log inhabiting. Frequently, underground nests open beneath the protection of bark fragments, sticks or boards. Hypogaeic species are to be expected under stones or boulders. One colony of *Leptothorax* was found in the bark of a live tree, and this genus occasionally uses the fallen acorns of black oaks. The subterranean yellow *Lasii* forage actively above ground at Smith during the nocturnal period, and species of *Camponotus* are also abroad in great numbers at night.

The log niche is well occupied in forest and woodland, and runways may be excavated partly in soil and log. A number of stages in the process of wood decay can be recognized. Shelford designated four (1913, pp. 238, 246), while Talbot lists six and for the most part these may be adhered to. Stage 1 (dead tree still intact), Stage 2 (bark loosened), Stage 3 (sapwood soft), Stage 4 (heartwood soft), Stage 5

FIG. 5. Black oak dunes in Kankakee County near Momence, Illinois. Photo by R. W. Miller.

FIG. 6. Beech-maple forest at Warren Woods near Lakeside, Michigan. Photo by Ecology Class, 1940.

(log crumbling), Stage 6 (merging with soil). Though a single ant species may be present in more than one stage, the following list serves to show that in logs the optimum conditions for different forms vary directly as the wood disintegrates, and indeed, this process is often hastened by the ants themselves. *Crematogaster lineolata* and *C. l. cerasi* are common types in the early phases. *Camponotus herculeanus* spp. alone seem able to tunnel in live trees or fresh wood, and in logs all *Camponotus* remain until the wood is honeycombed but not collapsed. *Aphenogaster fulva* spp. and *A. tennesseensis* with *Formica fusca subaenescens* also are most frequent in the middle stages of the succession. There is a tendency for hypogaeic species (which regularly require a moist environment) to be present in the middle and late stages when the wood is wet and spongy. Examples of these are the *Lasius umbratus* group and *Ponera coarctata pennsylvanica* (Table II).

These stages in log decay are convenient categories, but instances are encountered where it is arbitrary to assign a stage as the process is a continuous one. Phases three, four and five are the most confusing, and different sections of a large log show varying degrees of decomposition. Savely (1939) describes a fairly close connection between the stage of decay and the number of years duration of the process, but one difficulty lies in the fact that the rate of disintegration varies decidedly with different woods.

The delineation of ant-plant communities can be ascertained from the accompanying tabular data. Since ants are closely associated with soil and are somewhat fixed in position by rather permanent nest locations, it follows that modification of the ground stratum by the plant cover automatically affects the tolerances of ant species. In the list presented below the communities are labeled by the ant names most characteristic of them. Common and widely distributed species are not considered good indices.

ANT-PLANT COMMUNITIES

Prairie-meadow-pasture: *Formica cinerea neocinerea* and *Myrmica lobicornis fracticornis* community.
Foredune-cottonwood: *Monomorium minimum* and *Pheidole bicarinata* community.
Coniferous dune: *Iridomyrmex pruinosus analis* and *Paratrechina parvula* community.
Black oak dune: *Formica pallidefulva* spp., *Aphaenogaster treatae* and *Leptothorax texanus* community.
Mesophytic dune ravine forest: *Formica truncicola obscuriventris* and *Lasius flavus nearcticus* community.
Mixed oak forest: *Prenolepis imparis* and *Stenamma brevicorne* community.
Oak-hickory forest: *Camponotus herculeanus pennsylvanicus ferrugineus* community.
Beech-maple forest: *Aphaenogaster fulva* spp., *Myrmecina graminicola americana* and *Leptothorax longispinosus* community.
Bog forest: *Myrmica brevinodis* spp. and *Dolichoderus* spp. community.
Floodplain forest: *Strumigenys pergandei* community.
Forest margin: This community appears to be too variable to have any ant species restricted to it. (See discussion of *F. ulkei.*)
Marsh: Has only sporadic colonies of ants and none characteristic.
Railway and roadside: These habitats may be considered special extensions of the prairie and forest margin communities.

The importance of sand versus clay in the Chicago Region is not neglected but the differences among vegetation types are emphasized.

In the later stages of plant succession the nature of the soil (so modified by the plant types) probably has a minor effect upon the distribution of ants. Many species are log or humus dwellers and are thus removed

FIG. 7. The Region of Chicago. Permission has been granted to use this modification of "Plate I" from F. M. Fryxell's, "The Physiography of the Region of Chicago," published by the University of Chicago Press. (Three Rivers, Michigan, is too far east to be conveniently included on this map, and La Salle, Illinois, and Madison, Wisconsin, are too far west, but all are legitimately cited as localities for the region.)

from direct contact with the mineral substratum. Of the sixty-one ants present in black oak dunes and mixed oaks on clay, twenty-three species (37.7%) are common to both forests despite wide differences in soil. In comparing the sixty ants present in black oak dunes and

TABLE I

DISTRIBUTION OF ANTS

SPECIES	Prairie	Meadow	Pasture, Field	Forest margin	Foredune	Cottonwood dune	Jack pine dune	Black Oak dune	Mesophytic ravine	Oak Forest	Oak-hickory Forest	Beech-maple Forest	Floodplain Forest	Marsh	Bog Forest	Railway and Roadside	House	Log Stages	Under Stones, Logs, Wood, etc.	Abundance
1. *Ponera coarctata pennsylvanica*			x	x				x		x	x	x	x					2, 3, 4, 5, 6	s	C
2. *Ponera inexorata*																				R
3. *Proceratium croceum*																			dung	R
4. *Stigmatomma pallipes*									x	x	x							2, 3	l, dung	R
5. *Aphaenogaster fulva*				x				x		x		x			x			2, 3, 4, 5		U
6. *Aphaenogaster fulva aquia*			x						x	x	x	x	x		x			3, 4, 5	s, l, w	C
7. *Aphaenogaster fulva aquia picea*									x			x						3, 4, 5	w	U
8. *Aphaenogaster tennesseensis*				x				x		x	x	x						1, 2, 3, 4		C
9. *Aphaenogaster texana carolinensis*												x						5		R
10. *Aphaenogaster treatae*								x										3	w	U
11. *Crematogaster lineolata*							x	x				x						3, 4	l	C
12. *Crematogaster lineolata cerasi*			x	x			x	x		x	x	x	x					2, 3, 4, 5	s, l, w	A
13. *Leptothorax curvispinosus*		x						x		x	x	x	x					2, 3, 4, 5	acorn	C
14. *Leptothorax curvispinosus ambiguus*	x									x										R
15. *Leptothorax fortinodis*												x	x					1, 3 (?)		U
16. *Leptothorax longispinosus*												x						1, 2, 3, 4, 5		U
17. *Leptothorax texanus*																				U
18. *Monomorium minimum*					x	x	x	x												C
19. *Monomorium pharaonis*																	x			R
20. *Myrmecina graminicola americana*									x			x	x					4, 5	w	R
21. *Myrmica brevinodis brevinodis*			x												x				s	U
22. *Myrmica brevinodis brevispinosa*															x					U
23. *Myrmica lobicornis fracticornis*			x					x		x									s	A
24. *Myrmica punctiventris*									x			x						5		U
25. *Myrmica sabuleti americana*							x	x					x							A
26. *Myrmica schenki emeryana*								x		x			x						w	U
27. *Pheidole bicarinata*		x		x	x	x	x	x										2, 4, 5	w	C
28. *Pheidole morrisi*								x												U
29. *Pheidole pilifera*					x		x	x												U
30. *Solenopsis molesta*		x	x	x				x		x	x	x	x					2, 3, 5	s	C
31. *Stenamma brevicorne*		x								x								3 (?)		R
32. *Stenamma brevicorne schmitti*								x	x										w	R
33. *Strumigenys pergandei*													x					4		R
34. *Tetramorium caespitum*																	x			R
35. *Dolichoderus mariae*															x					R
36. *Dolichoderus plagiatus*															x					R
37. *Dolichoderus plagiatus inornatus*										x					x				Typha	R
38. *Dolichoderus plagiatus pustulatus*															x				Typha	R
39. *Dorymyrmex pyramicus flavus*					x															R
40. *Iridomyrmex pruinosus analis*							x	x												C
41. *Tapinoma sessile*			x	x						x	x	x	x		x			1, 2, 3, 4, 5	s	A
42. *Brachymyrmex heeri depilis*				x				x		x									s	U
43. *Camponotus caryae caryae nearcticus*								x				x	x					2, 3, 4		U
44. *Camponotus caryae caryae tanquaryi*										x		x								R
45. *Camponotus caryae discolor clarithorax*					x	x														U

TABLE I—(*Continued*)

	SPECIES	Prairie	Meadow	Pasture, Field	Forest margin	Foredune	Cottonwood dune	Jack pine dune	Black Oak dune	Mesophytic ravine	Oak Forest	Oak-hickory Forest	Beech-maple Forest	Floodplain Forest	Marsh	Bog Forest	Railway and Roadside	House	Log Stages	Under Stones, Logs, Wood, etc.	Abundance
46.	*Camponotus caryae subbarbatus*												x						3, 4		R
47.	*Camponotus castaneus*								x										3	1	U
48.	*Camponotus castaneus americanus*										x	x									U
49.	*Camponotus herculeanus ligniperda noveboracensis*			x	x				x		x		x			x			2, 3, 4		C
50.	*Camponotus herculeanus pennsylvanicus*							x	x	x	x	x	x	x					2, 3, 4, 5	1	A
51.	*Camponotus herculeanus pennsylvanicus ferrugineus*										x	x	x						3, 4, 5		U
52.	*Formica cinerea cinerea neocinerea*	x	x	x	x				x						x		x			w	A
53.	*Formica exsectoides exsectoides*		x		x						x						x				U
54.	*Formica fusca fusca subaenescens*									x	x				x				2, 3, 4, 6		A
55.	*Formica fusca fusca subsericea*	x		x			x		x	x	x	x		x	x	x	x		5		U
56.	*Formica neogagates neogagates*								x	x											U
57.	*Formica neogagates lasioides vetula*			x					x												U
58.	*Formica neplicula*	x																			U
59.	*Formica pallidefulva nitidiventris*	x	x	x					x		x									l, w	C
60.	*Formica pallidefulva nitidiventris fuscata*		x						x		x	x							3	s	U
61.	*Formica pallidefulva schaufussi*				x			x	x										5	w	R
62.	*Formica pallidefulva schaufussi incerta*							x	x		x								3, 4	l	R
63.	*Formica rufa aggerans*								x		x										U
64.	*Formica rufa aggerans melanotica*								x												U
65.	*Formica sanguinea aserva*										x										U
66.	*Formica sanguinea rubicunda*								x	x	x								5	l	R
67.	*Formica sanguinea subintegra*	x							x										4		R
68.	*Formica sanguinea submuda*											x		x							R
69.	*Formica truncicola integra*	x																			R
70.	*Formica truncicola obscuriventris*								x	x	x				x						A
71.	*Formica truncicola obscuriventris gymnomma*					x			x											l	C
72.	*Formica ulkei*			x	x				x		x				x	x					R
73.	*Lasius brevicornis*		x						x											l	R
74.	*Lasius claviger*			x					x			x							2	s	A
75.	*Lasius flavus nearcticus*								x	x			x						2, 3	s, l	C
76.	*Lasius interjectus*				x						x									s	R
77.	*Lasius latipes*								x												R
78.	*Lasius niger alienus americanus*			x	x				x	x	x	x	x	x		x			2, 3, 4, 5	s, l	A
79.	*Lasius niger neoniger*			x	x	x	x	x	x		x		x	x		x	x		4, 6	s, l, w	C
80.	*Lasius umbratus mixtus aphidicola*				x					x	x	x	x	x	x				3, 4, 5	l, w	A
81.	*Lasius umbratus mixtus speculiventris*			x									x						3	s	C
82.	*Paratrechina parvula*							x	x										3	l, w	R
83.	*Prenolepis imparis*			x					x		x	x									C
84.	*Prenolepis imparis testacea*								x		x										R
85.	*Polyergus rufescens breviceps*	x																			R
	Total	8	9	18	17	7	5	12	47	15	37	18	25	18	5	15	4	2			
	Percentage	9.4	10.6	21.2	20.0	8.2	6.0	14.1	55.3	17.6	43.5	21.2	30.0	21.2	6.0	17.6	4.7	2.4			

beech-maple forest on silt and clay, twelve (or 20%) are common to both despite wide differences in soil. The reduction in the percentage of common forms between these two habitats seems to parallel important differences in vegetational type. *Prenolepis imparis*, though noticeably dependent on the clay of morainic oak woodland for the construction of domed galleries, has been found also in the oak dunes. Oak forests, regardless of type, have the richest assemblage of species, and this might be traced to the variety of niches. Much humus is present, trees and shrubs add important strata, logs are numerous, yet openings appear where meadow conditions develop and there are even patches of bare earth.

TABLE II

	USE OF LOGS BY ANT SPECIES					
Stage of decomposition	1	2	3	4	5	6
Number of ant species	4	17	29	24	20	3
Perecntage	10.0	42.5	72.5	60.0	50.0	7.5

TABLE III

	ABUNDANCE OF ANT SPECIES			
Density of ant species	A Abundant	C Common	U Uncommon	R Rare
Number of ant species	9	19	31	26
Percentage	10.6	22.3	36.5	30.6

GEOGRAPHIC ORIGINS

The upper Mississippi Valley is similar in species composition to the St. Lawrence Drainage and the North Atlantic States. Most of the ant species in Connecticut, for instance, are found at least as far west as Illinois, Indiana and Wisconsin, and others cross the continent. *Formica*, *Lasius*, *Myrmica*, *Stenamma* and *Polyergus* which are Holarctic, and *Camponotus* which is cosmopolitan, contain over half (48) of the species known for the area. Nevertheless, the vegetational transitions in the Chicago Region are matched by ant species or genera with overlapping ranges. Some western members of the above genera have spread into Illinois, and several species have migrated southward from the Canadian Zone. A noteworthy southern invasion is represented by thirteen genera (of the twenty-five listed for Chicago) which are tropical in distribution. Since some of these are large groups with many tropical forms described, the one or few species in each characterizing our fauna indicates that these genera are near the limit of their northern penetration. Illustrations of the zoögeographic trends are briefly outlined below. Consult Wheeler's works (1917b, etc.) for the distribution of North American Formicidae.

From the East:

Several eastern species seem to be rarer in the middle west.
Ex. *Formica exsectoides* and *Lasius* (*A.*) *claviger*.
Tetramorium caespitum (introduced from Europe).

From the West:

Formica cinerea neocinerea.
Polyergus rufescens breviceps.
Myrmica brevinodis brevispinosa.

From the North:

Formica ulkei.
Camponotus herculeanus ligniperda noveboracensis.

From the South:

Pheidole (t)	*Leptothorax*	*Stigmatomma*
Solenopsis (t)	*Iridomyrmex*	
Crematogaster (t)	*Dorymyrmex*	
Monomorium (t)	*Dolichoderus*	
Strumigenys (t)	*Ponera*	
Aphaenogaster	*Proceratium*	

(All these genera are tropical; "t"—tropicopolitan.)

Myrmica brevinodis sulcinodoides Emery and *Formica perpilosa* Wheeler have been listed for the area by Talbot but I have not relocated them. *Camponotus caryae caryae minutus* Emery is difficult to distinguish from *nearcticus* and may not deserve formal recognition. *Iridomyrmex humilis* Mayr was present at the University Laboratory in 1934 but it has not been seen in recent years.

In addition to the seventy ants recorded by Dr. Talbot, twenty-two others have been collected, and doubtless more remain undiscovered. The following keys modified from various papers by Wheeler (1903a, b, 1905, 1910a, b, c, 1913, 1916, 1922), Smith (1931, 1936) and Cole (1940), trace the species represented in the author's collection.

Formicidae

KEY TO THE SUBFAMILIES[3]

1. Anal opening circular and terminal, usually bounded by a fringe of curved hairs (p. 469) ..... **FORMICINAE**
   Anal opening a narrow slit, ventral in position 2
2. Pedicel composed of two segments; sting usually well developed (p. 460), **MYRMICINAE**
   Pedicel of only one segment 3
3. A marked constriction between the first and second gastric segments (p. 459) ..... **PONERINAE**
   No constriction between the gastric segments; anal slit transverse (p. 467), **DOLICHODERINAE**

Ponerinae

KEY TO THE GENERA

1. Abdomen strongly decurved and pointing somewhat forward (p. 460), **Proceratium**
   Abdomen of the usual shape (not decurved) 2
2. Mandibles triangular, teeth minute (p. 460) ..... **Ponera**
   Mandibles linear, teeth conspicuous and bidenticulate (p. 460) .. **Stigmatomma**

[3]Key to the workers. The subfamilies Cerapachyinae, Dorylinae and Pseudomyrminae are not represented in the Lake Region.

Proceratium Roger

Proceratium croceum (Roger).—The single record of this species was obtained by Mr. Henry Dybas near the periphery of the area. Its presence beneath dung appears unusual as it is expected to occur in old logs.

Localities: Hamlet, Ind. (Dybas).

Stigmatomma Roger

Stigmatomma pallipes (Haldeman).—In the few places where I have collected this ant it seems always to be restricted to woodland areas and to be either in logs or under them. Two records of its occurrence are with other ants or at least in their immediate vicinity, namely: *Lasius* (*A.*) *claviger* and *Formica ulkei*. One specimen was found in cow dung. None but isolated individuals have been secured in each case despite efforts to locate the nests.

Localities: Palos Park, Ill. (R. Wheeler, Gregg); Ogden Dunes, Ind. (Lowrie, Gregg); Hamlet, Ind. (Dybas); Three Rivers, Mich.

Ponera Latreille

KEY TO THE SPECIES

Color brownish black; external borders of mandibles straight (p. 460), **coarctata pennsylvanica** Buckley

Color ferruginous yellow; external borders of mandibles sinuate (p. 460), **inexorata** Wheeler

Ponera coarctata pennsylvanica Buckley.[4]—In contrast to *Stigmatomma*, this ant is very common in certain habitats. The greatest number of nests was found in deep woods where the galleries ramified under bark or beneath the moss covering old logs. In one instance, many colonies were taken from under flat stones in a pasture. Winged males and females can be obtained in the latter part of August and early September.

Localities: New Lenox, Ill.; Hadley, Ill.; Palos Park, Ill.; Orland Park, Ill.; Momence, Ill.; Waukegan, Ill.; Volo, Ill.; Carlé Woods, Ill. (O. Park); Hodgkins, Ill. (Miller); Chicago, Ill. (Miller); Chesterton, Ind.; Smith, Ind.; Starke Co., Ind. (Dybas); Lakeside, Mich.

Ponera inexorata Wheeler.—According to Smith, this ant ranges from "Costa Rica through Mexico into the southern section of the United States." Its presence so far north seems difficult to explain, but its distribution is as yet uncertain owing to the meagre records of its occurrence. Its yellowish color serves easily to distinguish it.

Localities: Lake Geneva, Wis. (Lowrie).

Myrmicinae

KEY TO THE GENERA

1. Antennae 6-jointed; head cordiform (p. 461) . . . . . **Strumigenys**
   Antennae with more than six joints 2
2. Antennae 10-jointed, with a club composed of two joints (p. 461) . . **Solenopsis**
   Antennae 11- or 12-jointed 3
3. Postpetiole articulated to the dorsal surface of the gaster which is dorsally flattened and pointed at the tip (p. 461) . . . . . **Crematogaster**
   Postpetiole articulated in the usual place at the anterior end of the gaster . . 4

[4]Unless otherwise stated, the third name in trinomials is subspecific.

4. Posterior margin of clypeus elevated into a ridge bordering the antennal fossa 5
   Posterior margin of clypeus not thus elevated 6
5. Portion of clypeus in front of antennal fossa very narrow and reduced to a mere ridge (p. 462) ..... **Myrmecina**
   Portion of clypeus in front of antennal fossa narrow but not reduced to a mere ridge (p. 462) ..... **Tetramorium**
6. Workers strongly dimorphic (worker and soldier castes); antennae with a 3-jointed club (p. 462) ..... **Pheidole**
   Workers monomorphic; antennal club indistinct or not longer than the remainder of the funiculus 7
7. Last three antennal joints shorter than the remainder of the funiculus, and not forming a distinct club 8
   Last three antennal joints about equal to the remainder of the funiculus, and forming a distinct club 10
8. Posterior tibial spurs pectinated; body coarsely sculptured (p. 463) .. **Myrmica**
   Posterior tibial spurs not pectinated; body smooth or finely sculptured 9
9. Small, hypogaeic species with vestigeal eyes and two keels on the clypeus, (p. 464) ..... **Stenamma**
   Medium sized epigaeic species with well developed eyes and no clypeal keels (p. 465) ..... **Aphaenogaster**
10. Clypeus armed with a pair of ridges which project forward in the form of teeth; epinotum without spines or teeth (p. 466) ..... **Monomorium**
    Clypeus unarmed; epinotum armed with spines or teeth (p. 466) .. **Leptothorax**

Strumigenys F. Smith

Strumigenys (*Cephaloxys*) *pergandei* Emery.—Eleven specimens form a single record of this minute ant taken from the same rotting log as a large colony of *Lasius umbratus mixtus aphidicola*. The galleries of the two species were in very close proximity but it could not be ascertained whether they intercommunicated. The habitat is a flood-plain forest with a rather wet floor, and the nests were located in the upper side of the log.

Localities: Chesterton, Ind. (Talbot, Gregg).

Solenopsis Westwood

Solenopsis (*Diplorhoptrum*) *molesta* (Say).—This species is discovered frequently in the mound nests of *Formica ulkei* and *Formica exsectoides* where it occupies minute galleries tunneled in the walls separating the runways of the larger species. Of special interest is the disparity in size of the castes; the female is many times larger than her worker progeny. This condition has been traced to the lestobiotic tendencies of the insect. It is by no means dependent upon the thieving habit for sustenance, however, as flourishing nests with numerous alate females have been observed far from any large host species.

Localities: Waukegan, Ill.; Palos Park, Ill.; Chicago, Ill.; New Lenox, Ill.; Momence, Ill.; Dune Acres, Ind.; Three Rivers, Mich.; Lakeside, Mich.; Ogden Dunes, Ind.

Crematogaster Lund

KEY TO THE SPECIES

Dark brown to piceous black in color; hairs on thoracic dorsum numerous (p. 462) ..... **lineolata** Say
Paler in color, thorax reddish; hairs on thoracic dorsum restricted to the humeral angles (p. 462) ..... **lineolata cerasi** Fitch

Crematogaster lineolata Say.—With one exception this ant was found in dry, open woodland of the pine or black oak types, and it is a common inhabitant of the middle stages of log decay. Judging from the specimens in the collection, it is not as frequently encountered nor does it occur in as many seral units as the next species. Winged males have been captured in October.

Localities: Momence, Ill.; Waukegan, Ill.; Miller, Ind.; Dune Acres, Ind.; Ogden Dunes, Ind.; Lakeside, Mich.

Crematogaster lineolata var. *cerasi* Fitch.—Present in most environments from pasture to climax forest and all but the earliest and latest periods in the disintegration of logs or stumps. Laboratory populations of these *Crematogasters* have built small quantities of carton from pieces of moist sponge placed in the nests, but in the field no indications of aerial construction have been detected. A closely related species in Florida (*Crematogaster atkinsoni* Wheeler) makes a nest of paper, and one of these, sent through the courtesy of Dr. E. Morton Miller, when examined measured approximately six inches in diameter.

Winged males and females are present in the nests of *cerasi* during July, August, September and October.

Localities: New Lenox, Ill.; Volo, Ill.; Palos Park, Ill.; Chicago, Ill.; Waukegan, Ill.; Momence, Ill.; Orland Park, Ill.; Dune Acres, Ind.; Smith, Ind.; Valparaiso, Ind. (Lowrie, Gregg); Ogden Dunes, Ind.; Chesterton, Ind.; Starke Co., Ind. (Dybas); Three Rivers, Mich.; Lakeside, Mich.

Myrmecina Curtis

Myrmecina graminicola americana Emery.—This small and sluggish ant seems to be restricted to sheltered spots, particularly climax and subclimax forests where much shade exists. The colonies are small, and a few workers were gathered from such moist places as the underside of wood and the late stages of log decay. The species is rare for the Chicago Area, but Cole found that it is rather common in the buckeye-basswood forests of the Smoky Mountains.

Localities: Ogden Dunes, Ind. (Lowrie, Gregg); Chesterton, Ind.; Lakeside, Mich.; Smith. Ind. (Miller).

Tetramorium Mayr

Tetramorium caespitum Linnaeus.—It is an introduced European form and though common in some parts of the East, my collections indicate that it is still rare in the region about the head of Lake Michigan.

Localities: Chicago, Ill.

Pheidole Westwood[5]

KEY TO THE SPECIES

1. Epinotal spines reduced to low tubercles; color yellowish red (p. 463)..**morrisi**
   Epinotal spines well developed; brownish red to black..... 2
2. Head of soldier very large, coarsely sculptured throughout (p. 463)....**pilifera**
   Head of soldier smaller, posterior portion smooth and shining..... 3

[5]Soldiers are necessary for the adequate determination of *Pheidole* species, and the key is based on this caste.

3. Epinotal declivity with transverse striae; antennal scape long (p. 463), **bicarinata**
   Epinotal declivity smooth; antennal scapes shorter than in *bicarinata* (p. 463), **vinelandica**

Pheidole morrisi Forel.—Nests of this species are present in the various dunelands but they are abundant only in the black oak woods south of Momence. The formicaries are very populous, and upon being disturbed the ants swarm out in large numbers to defend themselves. An excellent aggregation of colonies was found in a blowout of one of the dunes, and each nest was placed among the roots of a grass hummock. Winged males were collected in August and females were present as early as June.

Localities: Momence, Ill.; Miller, Ind.; Dune Acres, Ind.

Pheidole pilifera (Roger).—The huge heads of the soldier make this ant especially striking in the field. Its powerful jaws supposedly serve to crush the seeds that are gathered and stored by the workers in the galleries of the nest. Except for one doubtful instance, all collections of the species have been in dune areas. The nest entrances were surrounded by craters as a rule larger than those of *Lasius*, and this usually helps to distinguish them from the latter.

Localities: Waukegan, Ill.; Momence, Ill.

Pheidole bicarinata Mayr.—It appears in a greater variety of habitats than either of the other *Pheidole* although it is restricted to sand or sand humus substrata. Several log stages and the underside of rotting wood are also included in its places of abode. Minute nest entrances marked by little or no crater deposits were located on the foredunes among shoots of marram grass. Their occurrence is fairly frequent.

Localities: Waukegan, Ill.; Momence, Ill.; Pine, Ind.; Miller, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.; Tremont, Ind.; Lakeside, Mich.

Pheidole vinelandica Forel.—This form is very close to *bicarinata* but can be distinguished from it by the characters mentioned in the key. It is recorded for the area by Dr. Talbot but is much rarer than the former species and does not occupy as many of the dune associes. At present I have obtained no specimens within the confines of the Chicago Region.

Myrmica Latreille

KEY TO THE SPECIES

1. Antennal scapes evenly bent at the base 2
   Antennal scapes sharply angled at the base 4
2. Gaster with hairs set in distinct punctures (p. 464) ..... **punctiventris**
   Gaster not punctate 3
3. Epinotal spines short, not longer than their distance apart at the base (p. 464) ..... **brevinodis brevispinosa**
   Epinotal spines longer than their distance apart at the base (p. 464), **brevinodis brevinodis**
4. Angle of antennal scape with a lateral, tooth-like projection (p. 464), **lobicornis fracticornis**
   Angle of scape possessing a transverse ridge or lamina across the bend (p. 464) ..... **sabuleti americana**
   Angle of scape expanded into a broad, spatulate flange (p. 464), **schencki emeryana**

Myrmica lobicornis fracticornis Emery.—One of the commonest myrmicines in the area, and it is apparently well adapted to either sand or clay substratum. The nest entrances are obscure although small craters are at times constructed, and colonies of considerable size are frequently unearthed. Under stones and beneath decaying wood are suitable nest sites; one colony was collected from the interior of an ***ulkei*** formicary. Their slow and deliberate movements and dark, earthy coloration make these ants inconspicuous against most soil backgrounds.

Localities: Palos Park, Ill.; New Lenox, Ill.; Waukegan, Ill.; Volo, Ill. (Miller); Momence, Ill. (Lowrie); Dune Acres, Ind. (Lowrie).

Myrmica sabuleti americana Weber.—At all but one station this species was found living on dune sand. The Chesterton specimens were obtained in a lush pawpaw thicket growing on alluvial deposits. The coloration of this ant is somewhat lighter and more reddish brown than the preceding species, and its epinotal spines are distinctly longer.

Localities: Waukegan, Ill. (Lowrie, Gregg); Momence, Ill. (Lowrie, Gregg); Miller, Ind.; Tremont, Ind.; Chesterton, Ind.

Myrmica schencki emeryana Forel.—As indicated in the key, this ant is distinguished by the pronounced enlargement of the antennal angle, but the color and sculpture are very similar to ***lobicornis***. The species seems to show no decided preference for either sand or clay soil although it is found usually in moist woodland and nests under stones or wood.

Localities: Dune Acres, Ind. (Lowrie, Gregg); Ogden Dunes, Ind. (Lowrie); Chesterton, Ind.; Volo, Ill.; Lake Geneva, Wis. (Lowrie).

Myrmica brevinodis brevinodis Emery.—According to my collections, this ant and the following species have a circumscribed distribution in the area. They are common only in a bog of the lake district where they inhabit the sphagnum mat, and the subspecies ***brevinodis*** was also secured from the fields adjacent to the bog. No nests were constructed in the swamp as the ants merely occupied the interstices of the mat.

Localities: Volo, Ill.; Miller, Ind.; Tremont, Ind.; Lakeside, Mich.

Myrmica brevinodis brevispinosa Wheeler.—All specimens were taken in the bog, and certain of them had been trapped in a pitcher plant.

Localities: Volo, Ill. (Miller, Gregg).

Myrmica punctiventris Roger.—Easily distinguished by the coarse punctures on the base of the gaster. The color is dark brown, the sculpture heavy and the epinotal spines long and sharp. It lives in climax and subclimax forests but does not seem to be abundant in them. Late stages of log decay are included as suitable nesting sites.

Localities: Carlé Woods, Ill. (O. Park); Smith, Ind.; Lakeside, Mich.

Stenamma Westwood

KEY TO THE SPECIES

Larger forms (2.5–4 mm.); body dark brown, base and tip of gaster yellowish; eye with more than four ommatidia in its greatest diameter (p. 465). . **brevicorne**

Smaller forms (2.4–3 mm.); body reddish brown; eye very small, with not more than three or four ommatidia in its greatest diameter (p. 465). . **brevicorne schmittii**

Stenamma brevicorne Mayr.—This is a small, hypogaeic ant living in logs or under the surface of leaf mold on the forest floor. Its colonies are small and quite uncommon. Winged males and females were taken from one nest in September.

Localities: Waukegan, Ill.; Palos Park, Ill.; Carlé Woods, Ill. (Park).

Stenamma brevicorne schmittii Wheeler.—The small size of the eye is the best means to separate this subspecies from the typical *brevicorne*. It exhibits the same preference for mesic conditions as the latter, and according to the local records it occurs only in wooded dunes. Winged females were captured in October.

Localities: Miller, Ind.; Ogden Dunes, Ind. (Lowrie, Gregg).

Aphaenogaster Mayr

KEY TO THE SPECIES

1. Antennal scape with long, flat lobe at the base; postpetiole markedly swollen (p. 465) ..... **treatae**
   Antennal scape without such a lobe; postpetiole not swollen 2
2. Head with posterior angles distinctly rounded (p. 465) ..... **texana carolinensis**
   Head with posterior corners obtusely angled 3
3. Epinotal spines at least as long as the base of the epinotum; color red (p. 465), **tennesseensis**
   Epinotal spines shorter than the base of the epinotum; color reddish brown to black 4
4. Epinotal spines somewhat longer than half the base of the epinotum; length 4.5–5 mm. (p. 466) ..... (typical) **fulva**
   Epinotal spines shorter than half the base of the epinotum; length 4–4.5 mm.. 5
5. Color reddish brown (p. 466) ..... **fulva aquia**
   Color pitchy black ..... **fulva aquia picea**

Aphaenogaster treatae Forel.—Black oak woodland of the several dunes seemed to be the only stations inhabited by this species. It tunnels in logs or the soil directly beneath them.

Localities: Dune Acres, Ind.; Miller, Ind.; Momence, Ill. (Lowrie, Gregg); Waukegan, Ill.

Aphaenogaster texana var. *carolinensis* Wheeler.—This ant belongs to a group with more southern distribution, and its occurrence in the Lake Region would seem unusual A single colony has been discovered in a crumbling log of the climax forest, the habitat most common for other *Aphaenogasters*. Structurally, it might be confused with *fulva aquia* or its variation *picea*, but the rounded condition of the posterior part of the head is a dependable diagnostic character.

Localities: Lakeside, Mich.

Aphaenogaster tennesseensis Mayr.—A beautiful red species of large size. The formicaries are very populous and may be found in the early and middle stages of log disintegration. At least none have been located in soil devoid of decaying wood. These ants are thought to be temporary parasites on species of *Aphaenogaster fulva*. The diminutive queen of *tennesseensis* invades the host colony to become established, after which the host individuals gradually disappear and leave a thriving nest of her progeny. One deälated female (probably a young queen) was collected on November sixth, and two alate females were found with their colony in July.

Localities: New Lenox, Ill.; Palos Park, Ill.; Orland Park, Ill.; Hadley, Ill.; Hodgkins, Ill.; Miller, Ind. (Lamar); Smith, Ind. (Lowrie, Gregg); Lakeside, Mich.; Three Rivers, Mich.; Coloma, Mich. (Ivaska).

Aphaenogaster fulva Roger.—All members of the *fulva* group are insects of moist, shady situations, particularly climax and subclimax forests. They are almost invariably associated with wood, being either in the late stages of log succession or in the leaf litter and soil under the log. Occasional colonies nest beneath stones. *A. fulva* is the rarest.

Localities: Palos Park, Ill.; Momence, Ill.; Dune Acres, Ind.; Tremont, Ind.; Smith, Ind.

Aphaenogaster fulva aquia (Buckley).—Localities: New Lenox, Ill.; Palos Park, Ill.; Volo, Ill.; Dune Acres, Ind.; Chesterton, Ind.; Smith, Ind.; Lakeside, Mich.

Aphaenogaster fulva aquia picea Emery.—Localities: Ogden Dunes, Ind.; Smith, Ind.; Lakeside, Mich.; Coloma, Mich. (Ivaska).

Monomorium Mayr

KEY TO THE SPECIES

Clypeal teeth prominent; length 1.5–2 mm.; color black (p. 466)..... **minimum**
Clypeal teeth indistinct; length 2–2.3 mm.; color yellow (p. 466)..... **pharaonis**

Monomorium minimum (Buckley).—In certain areas of the sand dunes this species is common, but, like *Solenopsis molesta*, it is so small and its colonies obscure that it is easily overlooked. A tiny crater may betray the nest opening although this is not a constant feature. Multiple queens are frequently observed in one colony, and up to twelve and fourteen have been recovered after excavation of complete nests. The species is especially adaptable to laboratory conditions. It will flourish in small plaster nests, and two to three thousand individuals may be reared if an abundance of insect meat is furnished.

Localities: Waukegan, Ill.; Momence, Ill. (Lowrie, Gregg); Ogden Dunes, Ind.

Monomorium pharaonis Linnaeus.—The ant is a house-infesting form in northern regions but originally came from "warmer regions of the Old World." Its distribution has become global. One record of this species (with the queen) was secured from a house in the city.

Localities: Chicago, Ill. (Sturtevant).

Leptothorax Mayr

KEY TO THE SPECIES

1. Antennae 11-jointed..... 2
   Antennae 12-jointed (p. 467)..... **texanus**
2. Epinotal spines very short, dentiform; color deep brown to black (p. 467), **fortinodis**
   Epinotal spines long..... 3
3. Color black; epinotal spines very long (p. 467)..... **longispinosus**
   Color yellow; epinotal spines shorter..... 4
4. Epinotal spines long, thin and curved; first gastric segment with two black or brown spots (p. 467)..... **curvispinosus**
   Epinotal spines short and straight (p. 467)..... **curvispinosus ambiguus**

Leptothorax texanus Wheeler.—Nowhere outside of black oak dunes was this ant found, and it appeared always to nest in the soil. Its presence in this habitat is probably correlated with its southern distribution.

Localities: Waukegan, Ill. (Lowrie, Gregg); Momence, Ill. (Lowrie, Gregg); Dune Acres, Ind. (Lowrie, Gregg).

Leptothorax fortinodis Mayr.—This species, like the following one, was observed in moist forested stations, and is an inhabitant of logs. One colony was discovered nesting in the bark of a live tree (Stage 1).

Localities: Chesterton, Ind.; Tremont, Ind.; Smith, Ind. (Kurtz, Gregg); New Lenox, Ill.

Leptothorax longispinosus Roger.—Beech-maple forest is the sole habitat for the species, according to the records, but I suspect that it may occur in other situations which approach the mesophytic environment of the forest. It is to be seen in most log stages.

Localities: Smith, Ind., Lakeside, Mich., Coloma, Mich. (Ivaska).

Leptothorax curvispinosus Mayr.—Of the several species in the area, this one is the most tolerant of conditions. It is distributed in a variety of communities, and occasionally occupies such special niches as fallen acorns and goldenrod galls. Rotting logs are also places of abode as would be expected. The small size of *Leptothorax* colonies and the individuals which compose them render their location difficult. Often, foraging workers can be gathered but the position of the nest is not revealed.

Localities: Palos Park, Ill.; Orland Park, Ill.; Hadley, Ill.; Momence, Ill. (Lowrie, Gregg); Dune Acres, Ind. (Lowrie); Chesterton, Ind. (Lowrie); Smith, Ind.; Lakeside, Mich.

Leptothorax curvispinosus ambiguus Emery.—Occurs in both woodland and prairie, but no instances of log dwelling were evident.

Localities: Palos Park, Ill.; Chicago, Ill.; Harvey, Ill.

Dolichoderinae

KEY TO THE GENERA

1. Integument hard and brittle; declivity of the epinotum strongly concave (p. 467) ..... **Dolichoderus**
   Integument thin and flexible; epinotal declivity not strongly concave 2
2. Petiolar scale vestigial or absent (p. 468) ..... **Tapinoma**
   Petiolar scale well developed 3
3. Epinotum with a conical elevation (p. 468) ..... **Dorymyrmex**
   Epinotum rounded, without a conical elevation (p. 468) ..... **Iridomyrmex**

Dolichoderus Lund

KEY TO THE SPECIES

1. Head and thorax with shallow foveolae, shining 2
   Head and thorax coarsely and deeply foveolate, subopaque 3
2. Epinotal concavity with a strong, median longitudinal ridge; head, thorax and petiole yellowish red (p. 468) ..... **mariae**
   Epinotal concavity without ridge; color brownish to black, base of gaster with reddish yellow spots (p. 468) ..... **plagiatus pustulatus**
3. Base of gaster with reddish yellow spots (p. 468) ..... **plagiatus**
   Gaster entirely black (p. 468) ..... **plagiatus inornatus**

Dolichoderus (*Hypoclinea*) *mariae* Forel.—A tamarack bog with open water in its center was practically the only place where species of this genus were obtained. To find members of a group with tropical distribution in a bog of this area (the organisms of which are relicts of a more northern fauna and flora) seems incongruous, but I am unable at present to offer an explanation. The colonies collected personally were in each case located in the stalk and between the leaves of dried *Typha*.

The rather striking species, *D. mariae*, is represented only by one specimen.

Localities: Volo, Ill.

Dolichoderus (*Hypoclinea*) *plagiatus* Mayr.—This ant appeared to be far less abundant than its variety which follows.

Localities: Volo, Ill. (Lowrie).

Dolichoderus (*Hypoclinea*) *plagiatus* var. *inornatus* Wheeler.—In addition to the tamarack bog, one collection of the species was made in a white oak woodland. This ant was present in noticeably greater numbers than any of the others in the genus.

Localities: Volo. Ill. (Lowrie, Schweitzer, Gregg); Ogden Dunes, Ind.; Dune Acres, Ind. (Lowrie).

Dolichoderus (*Hypoclinea*) *plagiatus pustulatus* Mayr.—Localities: Volo, Ill.

Tapinoma Förster

Tapinoma sessile (Say).—This insect can be confused with the varities of *Lasius niger*, but the slit-like anal opening and the low petiolar scale will always distinguish *Tapinoma*. Further, when handled *Tapinoma* raises the gaster and emits a whitish fluid that has the odor of cocoa butter, and this is the best field mark. The ants nest in a variety of natural communities, and are to be found in different log stages and under stones or debris.

Localities: Palos Park, Ill.; New Lenox, Ill.; Volo, Ill., Dune Acres, Ind.; Chesterton, Ind.; Smith, Ind.; Three Rivers, Mich.; Lake Como, Wis. (Lowrie).

Dorymyrmex Mayr

Dorymyrmex pyramicus var. *flavus* McCook.—A single record of this ant is from dry duneland, and the specimens were living with or near a colony of *Pheidole pilifera*. The species *pyramicus* is known to associate itself with colonies of *Pogonomyrmex* in the western states, and it is said to appropriate some of the food of the latter form to its own use. The occurrence of *flavus* in the Great Lakes Region probably represents a portion of the northern limit of the range of the species.

Localities: Waukegan, Ill.

Iridomyrmex Mayr

KEY TO THE SPECIES

Head and thorax brownish, gaster light yellow (p. 468).....**pruinosus analis**
Head, thorax and gaster reddish brown (p. 469).....**humilis**

Iridomyrmex pruinosus var. *analis* (André).—It seems to be confined to black oak and Jack pine dunes, and is very active over the arid sand

of these areas. Craters are constructed which are almost identical with those of *Lasius*.

Localities: Momence, Ill.; Ogden Dunes, Ind.

Iridomyrmex humilis Mayr.—The Argentine ant. It is now cosmopolitan, having spread from its home in South America, and infests houses especially in the cooler parts of its range. It has not been taken from the natural environments about Chicago, but Dr. Talbot collected it from the zoological laboratory at the University. It has since disappeared, and the author was unable to get samples. The head of ***humilis*** has a peculiar, subtriangular shape, and this serves further to separate it from ***pruinosus*** in which the head is subrectangular.

Formicinae

KEY TO THE GENERA

1. Antennae 9-jointed (p. 469) ..... **Brachymyrmex**
   Antennae with more than nine joints 2
2. Workers strongly polymorphic; anterior portion of thorax flattened dorsally, and triangular in outline when viewed from above (p. 477) ..... **Camponotus**
   Workers monomorphic or sometimes variable in size; thorax constituted differently 3
3. Clypeal fossa distinctly separate from antennal fossa 4
   Clypeal fossa confluent with antennal fossa 5
4. Body covered with long, stiff hairs; mesonotum constricted but not subcylindrical (p. 469) ..... **Paratrechina**
   Body with only delicate, flexible hairs; mesonotum constricted and subcylindrical in shape (p. 469) ..... **Prenolepis**
5. Joints 2–5 of funiculus shorter or not longer than the succeeding joints; ocelli usually absent (p. 470) ..... **Lasius**
   Joints 2–5 of funiculus longer than the remaining joints; ocelli present 6
6. Mandibles with broad, dentate apical border (p. 472) ..... **Formica**
   Mandibles narrow, falcate and pointed (p. 476) ..... **Polyergus**

Brachymyrmex Mayr

Brachymyrmex heeri depilis Emery.—It is distributed in woodland and forest margin, nesting in the soil directly or under stones. In size it ranks among the smallest, and the shortness of the antennae easily sets it apart from other ants in the region.

Localities: Palos Park, Ill.; Chicago, Ill. (Windsor); Dune Acres, Ind.

Paratrechina Motschoulsky

Paratrechina (***Nylanderia***) ***parvula*** (Mayr).—In logs and under debris in sandy habitats. Its long setae readily isolate it from any other ant in the area. ***Lasius niger*** is the main species with which it might be confounded.

Localities: Waukegan, Ill.; Momence, Ill.; Ogden Dunes, Ind.; Dune Acres, Ind.

Prenolepis Forel

KEY TO THE SPECIES

Body piceous black, mandibles, antennae, tibiae and tarsi lighter (p. 470) .. **imparis**
Body brownish or reddish yellow, gaster and occipital region darker (p. 470), **imparis testacea**

Prenolepis imparis (Say).—This species appears predominantly in woodlands built upon a substratum of clay. Small craters mark the entrance to the nests, and a short distance below the surface are domed chambers where the brood and repletes may be found. The gorged condition of the latter individuals results from imbibing the secretions of aphids, and recalls the honey ants of the Southwestern United States in which the replete has evolved further.

Localities: Palos Park, Ill.; Orland Park, Ill.; Volo, Ill.; Cary, Ill. (Schweitzer); Chesterton, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.; Three Rivers, Mich.; Lake Geneva, Wis. (Lowrie); Miller, Ind. (Miller).

Prenolepis imparis var. *testacea* Emery.—The habitat requirements are the same as for the typical *imparis*, but this variety has been encountered less frequently.

Localities: Palos Park, Ill.; Miller, Ind.

Lasius Fabricius

KEY TO THE SPECIES

1. Maxillary palpi 6-jointed 2
   Maxillary palpi 3-jointed ..... (subgenus *Acanthomyops*) 7
2. Terminal joints of maxillary palpi long, subequal; eyes medium-sized; epigaeic ..... (subgenus *Lasius*) 3
   Terminal joints of maxillary palpi successively diminishing toward the apex; eyes minute; hypogaeic ..... (subgenus *Chthonolasius*) 4
3. Scapes and legs without erect hairs (p. 470) ..... **niger alienus americanus**
   Scapes and legs beset with erect hairs (p. 471) ..... **niger neoniger**
4. Tips of scapes not quite reaching to posterior corners of the head (p. 471), **brevicornis**
   Tips of scapes surpassing posterior corners of head 5
5. Tips of antennal scapes but slightly surpassing posterior corners of head; color pale yellow (p. 471) ..... **flavus nearcticus**
   Tips of antennal scapes extending some distance beyond posterior corners of head; color brownish yellow 6
6. Gaster subopaque; with appressed hairs (p. 471) ... **umbratus mixtus aphidicola**
   Gaster smooth and shining; without appressed hairs (p. 471), **umbratus mixtus speculiventris**
7. Petiole low and blunt above in profile (p. 471) ..... **latipes**
   Petiole higher, thin, and acute above in profile 8
8. Penultimate joints of distally incrassated antennal funiculus somewhat broader than long; gaster with abundant long hairs (p. 472) ..... **claviger**
   Penultimate joints of but slightly incrassated funiculus not broader than long; gaster with sparse long hairs (p. 472) ..... **interjectus**

Lasius niger alienus americanus Emery.—This is an exceedingly common ant and is found from dry, open pastures to the interior of climax forests. It will nest in most stages of logs and under sticks or stones or other suitable cover. The colonies are large, hence they are able to produce numerous winged males and females which appear in late summer. The workers have often been observed tending aphids for their secretions, and the species also cultivates the corn root aphid in its subterranean passages. As a result of this habit it is of considerable importance as an agricultural pest.

Localities: New Lenox, Ill.; Palos Park, Ill.; Hadley, Ill.; Volo, Ill.; Ogden Dunes, Ind.; Dune Acres, Ind.; Chesterton, Ind.; Hammond, Ind.; Smith, Ind.; Lakeside, Mich.; Coloma, Mich. (Ivaska); Three Rivers, Mich.; Lake Como, Wis. (Lowrie).

Lasius niger var. *neoniger* Emery.—This variety, though very abundant and widespread, I have not collected from the beech-maple forests or subclimax. *Neoniger* overlaps with *americanus* in many habitats but replaces the latter in pioneer dunes, and is the commonest ant in the lawns and gardens of urban dwellings. Nests have been located under stones and in some decaying logs.

Localities: Chicago, Ill.; Volo, Ill.; New Lenox, Ill.; Waukegan, Ill.; Momence, Ill.; Pine, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.; Chesterton, Ind.; Lakeside, Mich.; Coloma, Mich. (Ivaska).

Lasius (*Chthonolasius*) *brevicornis* Emery.—It is most often found under logs or stones in well drained situations. The indications from my records are that it is a rare to uncommon species.

Localities: Willow Springs, Ill. (Windsor); Dune Acres, Ind.

Lasius (*Chthonolasius*) *flavus nearcticus* Wheeler.—In the majority of cases this ant occurred in moist, shady woods and under logs and stones. Its extremely pale yellow color correlated with its subterranean habits make the species easy to distinguish.

Localities: Ogden Dunes, Ind. (Lowrie, Gregg); Smith, Ind.; Lakeside, Mich.

Lasius (*Chthonolasius*) *umbratus mixtus aphidicola* Walsh.—This is the most abundant of the hypogaeic species of *Lasius*. Its colonies are usually large and are placed in and under logs or rotting stumps.[6] As indicated by the varietal name, they have a propensity for cultivating aphids and coccids which are sometimes present in large numbers. Winged males and females of *aphidicola* were taken from nests in April, August, September and October.[7]

Localities: Palos Park, Ill.; New Lenox, Ill.; Aurora, Ill. (Dybas); Chicago, Ill.; Miller, Ind.; Hammond, Ind.; Chesterton, Ind.; Smith, Ind. (Kurtz, Gregg); Lakeside, Mich.; Lake Geneva, Wis. (Lowrie); Madison, Wis. (Collector ?).

Lasius (*Chthonolasius*) *umbratus mixtus speculiventris* Emery.[8]—Much rarer than the preceding variety.

Localities: New Lenox, Ill.; Volo, Ill.; Smith, Ind.

Lasius (*Acanthomyops*) *latipes* Walsh.—Members of the subgenus *Acanthomyops* are rare in the Chicago Region although they seem to be more common in the Eastern States. A colony of *latipes* in dune sand was preparing to swarm in the late afternoon, and a number of the Beta females were captured as well as males and workers (August).

Localities: Waukegan, Ill.; Hessville, Ind. (Wenzel).

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[6] A group of nests in one of the filled ponds of the Gary Pond Series at Hammond was constructed of rich muck and stood two to three feet high with diameters of somewhat smaller dimension. The ground about them was doubtless subject to flooding at certain periods. (Located by Mr. S. A. Windsor.)

[7] In my possession are two cases of the temporary parasitism of *Lasius umbratus mixtus aphidicola* on *Lasius niger alienus americanus*, and one case on *Lasius niger neoniger*. In each instance, however, only the invading queens of the parasite were obtained and none of their progeny had apparently developed.

[8] A single doubtful specimen of *Lasius umbratus minutus* Emery from Chicago, Illinois, was identified too late to be fitted into the key. This subspecies may be distinguished from the others by its small size (average less than 4 mm.) and the dense pubescence with erect hairs on the gaster. The gaster is subopaque.

Lasius (*Acanthomyops*) *claviger* Roger.—Localities: Momence, Ill.; Lake Geneva, Wis. (Lowrie); Three Rivers, Mich.

Lasius (*Acanthomyops*) *interjectus* Mayr.—Under stones in open woodlands or forest margin. Two colonies only were discovered.

Localities: Palos Park, Ill.; New Lenox, Ill.

Formica Linnaeus

KEY TO THE SPECIES

1. First funicular joint of worker and female about as long as the second and third joints taken together.....(subgenus **Proformica**) 2
   First funicular joint of worker and female distinctly shorter than the second and third taken together...(subgenus **Formica** and subgenus **Neoformica**) 3
2. Antennal scapes with erect hairs (p. 473).....**neogagates lasioides vetula**
   Antennal scapes without erect hairs (p. 473).....**neogagates neogagates**
3. Clypeus emarginate or notched in the middle of the anterior border..... 4
   Clypeus not emarginate..... 7
4. Gaster black, head and thorax deep red..... 5
   Gaster brown, head and thorax light red..... 6
5. Front and vertex more or less infuscated (p. 473).....**sanguinea aserva**
   Front and vertex not infuscated (p. 473).....**sanguinea rubicunda**
6. Hairs almost always absent from the thoracic dorsum and petiolar border, short and few on the head and gaster (p. 473).....**sanguinea subnuda**
   Hairs present on the thoracic dorsum, longer and more numerous on the head and gaster (p. 473).....**sanguinea subintegra**
7. Posterior border of head broadly excised; sides of head subparallel..... 8
   Posterior border of head straight or convex, or at most very feebly excised; sides of head converging anteriorly..... 9
8. Pronotum and mesonotum with coarse yellow hairs; posterior half of head black (p. 474).....**ulkei**
   Pronotum and mesonotum without hairs; head completely red (p. 474), **exsectoides exsectoides**
9. Body of worker stout; head of largest individuals not longer than broad. Funicular joints 2–3 longer and more slender than joints 6–8. Superior border of petiole usually sharp. Color light or dark red with brown or black gaster.....10
   Body of worker slender; head of largest individuals distinctly longer than broad. Funicular joints 2–3 at most slightly more slender than joints 6–8. Petiole narrow with superior border blunt. Color black, brown or yellowish brown.....15
10. Female smaller or not larger than the largest workers (p. 474).....**nepticula**
    Female larger than the largest workers.....11
11. Erect hairs absent on the gula and upper surface of head and thorax (p. 474).....**truncicola integra**
    Erect hairs present on the gula and upper surface of head and thorax.....12
12. Eyes hairless (p. 474).....**truncicola obscuriventris gymnomma**
    Eyes hairy.....13
13. Head and thorax of small workers scarcely or not at all darker than in the largest workers (p. 474).....**truncicola obscuriventris**
    Head and thorax of small workers decidedly darker than in the largest workers.....14
14. Thorax of large workers bright red like the head or at most very feebly infuscated; pubescence on gaster dense (p. 474).....**rufa aggerans**
    Thorax of large workers deeply infuscated; pubescence on gaster more dilute (p. 475).....**rufa aggerans melanotica**
15. Median joints of funiculus less than 1½ times as long as broad; scapes distinctly curved at the base. Thorax of worker rather short; petiolar scale flattened posteriorly.....16
    Median joints of funiculus more than 1½ times as long as broad; scapes scarcely curved at the base. Thorax of worker longer; petiole convex posteriorly.....(subgenus **Neoformica**) 18

16. Gula with erect hairs; body dark brown (p. 475). . **cinerea cinerea neocinerea**
Gula without erect hairs; body black 17
17. Gaster opaque (silky lustre), pubescence dense (p. 475), **fusca fusca subsericea**
Gaster shining (metallic lustre), very sparsely pubescent (p. 475), **fusca fusca subaenescens**
18. Erect hairs present on the gula and petiolar border 19
Erect hairs absent on the gula and petiolar border 20
19. Hairs on gula and petiole numerous and conspicuous; color light (p. 475), **pallidefulva schaufussi**
Hairs on gula and petiole few, often lacking on one or the other; color darker (p. 476) . . . . . **pallidefulva schaufussi incerta**
20. Head and thorax brown or reddish, gaster very dark (p. 476), **pallidefulva nitidiventris**
Head and thorax as well as gaster very dark brown to piceous black (p. 476), **pallidefulva nitidiventris fuscata**

Formica (*Proformica*) *neogagates neogagates* Emery.—Ants of the subgenus *Proformica* are structurally intermediate between *Lasius* and the subgenus *Formica* (s. str.). Their colonies are located in the soil and, in fact, the craters surrounding the nest entrances resemble oversized craters of *Lasius*. The two species in the area were fairly abundant in sandy soil; one record of the variation *vetula* was obtained from clay soil.

Localities: Momence, Ill.; Waukegan, Ill.; Chicago, Ill.; Ogden Dunes, Ind.; Tremont, Ind.

Formica (*Proformica*) *neogagates lasioides vetula* Wheeler.—Localities: Waukegan, Ill. (Lowrie, Gregg); Orland Park, Ill.; Dune Acres, Ind.; Lake Como, Wis. (Lowrie).

Formica sanguinea aserva Forel.—Species of the *sanguinea* group are represented in a fair variety of communities but seemed to prefer areas with stands of trees. The subspecies *aserva* is the rarest of the four known from the region, and it was taken on but one occasion.

Localities: Palos Park, Ill.

Formica sanguinea rubicunda Emery.—This is easily the most common member of the group. It will nest in late stages of log decomposition and under stumps, and is found from the seral habitats of the dunes to the open woodlands on clay. An especially fine group of nests was discovered by Mr. Windsor on the hilltops overlooking the Sag Channel at Palos Park. The species are noted for their dulotic or slave-making habits and most frequently use the workers of *subsericea* as hosts. The finish of a raid by *sanguinea* was seen as the captured pupae were being carried from the nest of the slave species, but I was not present when the process began.

Localities: Palos Park, Ill.; Harvey, Ill.; Momence, Ill. (Lowrie, Gregg); Ogden Dunes, Ind.; Dune Acres, Ind.; Delavan Lake, Wis. (Dybas).

Formica sanguinea subnuda Emery.—Observed at two widely separated stations, but probably more common than the records indicate.

Localities: Chicago, Ill.; Three Rivers, Mich.

Formica sanguinea subintegra Emery.—Like the preceding species, it is fairly common.

Localities: Chicago, Ill.; Momence, Ill.

Formica ulkei Emery.—This ant is characteristic of the boreal fauna, and according to Wheeler is peculiar to the Canadian Zone. It is present in the vicinity of Chicago in very local spots, and it is probable that our collections represent the southern edge of its range. A striking aggregation of nests at Palos Park was visited many times, and it has furnished much material for other investigators. Several stations have yielded specimens of *ulkei*, as indicated, but a group of nests reported from Palatine, Illinois, was not my privilege to observe. Where a large number of colonies occupy a circumscribed area, the correlation of their distribution with the forest margin habitat is almost diagramatic.

Localities: Palos Park, Ill.; Waukegan, Ill. (Lowrie, Gregg); Volo, Ill.; Dune Acres, Ind.; Smith, Ind. (Maina); Lakeside, Mich.

Formica exsectoides exsectoides Forel.[9]—This species is closely allied to *ulkei* and is the only other example of the *exsecta* group known to me in the area. It is apparently much commoner in the Eastern States, and efforts to locate nests at the head of the lake have been rewarded with meager returns.

Localities: New Lenox, Ill.; Palos Park, Ill.; Tremont, Ind. (Wiersinski); Lakeside, Mich.; Chicago Heights, Ill.

Formica nepticula Wheeler.—The *microgyna* group, to which this species belongs, is practically impossible to determine without the queens as it is the disparity in stature of the female caste that differentiates these ants from species of the *rufa* group. An adequate series of individuals came from a single colony in the prairies southwest of the city.

Localities: Chicago, Ill.

Formica truncicola obscuriventris Mayr.—Ants of the *rufa* group are usually exemplified by this form, but the others appear in varying degrees of abundance. *Obscuriventris* is commonest in the wooded parts of the dunes and especially in the more mesophytic portions. Its nests ramify through the leaf-litter, and the exact entrance leading to the main galleries is not easy to discern. They have been recovered from the soil beneath badly decayed stumps.

Localities: Waukegan, Ill.; Ogden Dunes, Ind.; Dune Acres, Ind.; Tremont, Ind.; "Indiana Sand Dunes" (Dropkin).

Formica truncicola obscuriventris gymnomma Wheeler.—Localities: Waukegan, Ill.; Momence, Ill. (Lowrie).

Formica truncicola integra Nylander.—Found alone in the prairies southwest of the city.

Localities: Chicago, Ill.; Harvey, Ill.

Formica rufa aggerans Wheeler.—This species and the following variety were first noticed in the dry, black oak woodland of the Waukegan Dunes. The mounds are scarcely raised above the surrounding ground level, and a peculiar feature of the nest is its almost

[9] *Formica exsectoides exsectoides davisi* Wheeler has been found in the collection since composition of this paper, and was obtained from forest margin at New Lenox, Illinois. It may be separated from *exsectoides* by the infuscation of the vertex, occiput and pro- and mesonotum.

entire construction of thatch or small twigs heaped into the center and extending some distance into the interior of the colony.

Localities: Waukegan, Ill.; Palos Park, Ill.

Formica rufa aggerans melanotica Emery.—As indicated in the key, this is a very dark variety of *aggerans*. It occurs in essentially the same situations as the latter, but was not seen on clay.

Localities: Waukegan, Ill.

Formica cinerea cinerea neocinerea Wheeler.—The predominate formicid of the prairies and meadows is this member of the *fusca* group. Its mounds are low and usually a foot or two in diameter, and in some spots they are but a few paces apart. One astonishing nest measured approximately six feet across. Occasionally, a high dome may be built in low lying grasslands, but a correlation of this style of nest with inundation of the habitat was not verified. The species serves as host for some of the slave-making ants.

Localities: Chicago, Ill.; Palos Park, Ill.; Orland Park, Ill.; Waukegan, Ill.; Volo, Ill.; Smith, Ind.

Formica fusca fusca subsericea Say.—Aside from the varieties of *Lasius niger*, this is our commonest ant, and as would be expected, it tolerates a wide range of environmental fluctuations. It has been observed to forage over hot sand in the pioneer stages of dune succession, and is equally adjusted to the shade of ravine forests. Many workers have been seen on the branches and foliage of trees or upon the understory where they actively search the secretions of aphids. As with *neocinerea*, this ant is frequently parasitized by species of slave-makers.

Localities: Palos Park, Ill.; Chicago, Ill.; New Lenox, Ill.; Waukegan, Ill.; Volo, Ill.; Momence, Ill.; Ogden Dunes, Ind.; Dune Acres, Ind.; Lakeside, Mich.; Three Rivers, Mich.; Lake Como., Wis. (Lowrie).

Formica fusca fusca subaenescens Emery.—This variety of *fusca* is much rarer than the preceding one, and in addition is relatively stenokous. Moist woodlands and especially the advanced stages of logs are its places of abode. The shiny gaster distinguishes it from *subsericea*.

Localities: Palos Park, Ill.; Chicago, Ill.; Volo, Ill. (Lowrie, Gregg); Ogden Dunes, Ind.

Formica (*Neoformica*) *pallidefulva schaufussi* Mayr.—The four ants of this group in our fauna are excellent indicators of the black oak associes in dune succession, for under a high percentage of the sticks and logs in these woods one may find the openings to their inconspicuous nests. The prickly pear cactus (*Opuntia*) often conceals a formicary under its orbicular stems. A few colonies were noticed in pastures and grasslands. The workers seem to be very timid, and they are used extensively as slaves by the different species of *sanguinea*. The subspecies *schaufussi* is less common than others of the group, but it is the largest. The characters given in the key, while somewhat variable, are nevertheless the most satisfactory. A series of specimens is indispensable for taxonomic determination as there is considerable overlap among individuals of one colony.

Localities: Palos Park, Ill.; Momence, Ill. (Lowrie, Gregg); Miller, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.

Formica (*Neoformica*) *pallidefulva schaufussi incerta* Emery.—Localities: Palos Park, Ill.; Momence, Ill.; Miller, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.

Formica (*Neoformica*) *pallidefulva nitidiventris* Emery.—Localities: Palos Park, Ill.; New Lenox, Ill.; Momence, Ill. (Lowrie, Gregg); Waukegan, Ill.; Volo, Ill.; Dune Acres, Ind. (Lowrie, Gregg); Miller, Ind.; Lakeside, Mich.

Formica (*Neoformica*) *pallidefulva nitidiventris fuscata* Emery.—Localities: Palos Park, Ill.; Momence, Ill. (Lowrie, Gregg); Ogden Dunes, Ind.; Dune Acres, Ind.

Polyergus Latreille

KEY TO THE SPECIES

Antennal scapes distinctly short, not reaching to posterior corners of head; long, stiff hairs on both dorsum and ventrum of gaster; color light red (p. 476), **rufescens breviceps**

Antennal scapes reaching to posterior corners of head; long, stiff hairs on the gaster almost confined to the ventrum; color dark red (p. 476)..... **lucidus**

Polyergus rufescens breviceps Emery.—This handsome ant is unquestionably the most interesting species in the region. It is very rare, and as yet only four nests have been seen. These are located at two well separated stations which were made known to me through the generosity of Mr. A. S. Windsor. The genus *Polyergus* is a group of obligatory slave-makers, and unlike *sanguinea* is dependent upon its host, apparently, for the performance of such essential activities as feeding, brood care and construction of nests. The specialized falcate mandibles are employed for both offense and defense in raids on colonies of the *fusca* and *Neoformica* species, during which pupae of these ants are carried off to be hatched in the *Polyergus* nest. All the colonies observed were in the prairies, and correspondingly the auxiliaries used were derived from the numerous nests of *neocinerea* in the same community. Though one of the localities has been visited often, the ants have provided no military display. On July 13, 1939, males and winged females were captured as they swarmed from the nest, and on August 10, 1940, the phenomenon was repeated. *Rufescens* and its subdivisions range widely through the western part of the United States with the subspecies *breviceps* extending its occurrence to Illinois which is probably the boundary of its territory.

Localities: Harvey, Ill. (Windsor, Gregg); Mokena, Ill. (Windsor, Gregg).

Polygerus lucidus Mayr.—This is the typical species of the Eastern States, but it is found as far west as the Great Plains and therefore overlaps with *breviceps*. I have not yet obtained individuals from the Chicago Area, but *lucidus* has been reported from Pine, Indiana, by Dr. Wheeler and its presence will doubtless be confirmed with further search.

Camponotus Mayr

KEY TO THE SPECIES

1. Anterior clypeal border with a distinct, median emargination, (subgenus **Myrmentoma**) 2
   Anterior clypeal border without such an emargination, (subgenus **Camponotus**) 5
2. Cheeks and clypeus with elongate, piligerous foveolae 4
   Cheeks and clypeus without such foveolae 3
3. Body black, except prothorax which is dark red (sometimes infuscated), (p. 477) . . . . . **caryae caryae nearcticus**
   Body dark, but thorax and at least basal half of first gastric segment yellowish red (sometimes mottled), (p. 477) . . . . . **caryae caryae tanquaryi**
4. Brownish yellow, gaster paler with brown bands (p. 477) . . . **caryae subbarbatus**
   Head blackish brown, thorax red (p. 477) . . . . . **caryae discolor clarithorax**
5. Head of worker major smooth and shining behind; color at least in part light red or yellow 6
   Head of worker major opaque or feebly shining behind; color black or black and darker red 7
6. Body yellow or light red throughout (p. 477) . . . . . **castaneus**
   Head at least dark brown or black (p. 477) . . . . . **castaneus americanus**
7. Gaster opaque or subopaque; pubescence on gaster long 8
   Gaster shining, with short sparse pubescence; thorax deep red (p. 478), **herculeanus ligniperda noveboracensis**
8. Color black throughout; pubescence white (p. 478) . . **herculeanus pennsylvanicus**
   Posterior portion of thorax, petiole, legs and base of gaster reddish yellow; pubescence and pilosity yellow (p. 478), **herculeanus pennsylvanicus ferrugineus**

Camponotus (*Myrmentoma*) *caryae caryae nearcticus* Emery.—The ants of the *caryae* group are not as abundant as other *Camponoti*, but can be found if one is careful to examine dead twigs and early stages of logs. They seem to exhibit some preference for rather dry wood. The variety *nearcticus* is the commonest form and is present in black oak dunes and climax forest chiefly.

Localities: Waukegan, Ill.; Momence, Ill.; Aurora, Ill. (Dybas); Chesterton, Ind.; Dune Acres, Ind.; Tremont, Ind.; Beverly Shores, Ind.(Dybas); Smith, Ind.

Camponotus (*Myrmentoma*) *caryae caryae tanquaryi* Wheeler.—Localities: Palos Park, Ill.; Smith, Ind.

Camponotus (*Myrmentoma*) *caryae subbarbatus* Emery.—Localities: Smith, Ind.; Lakeside, Mich. (Miller).

Camponotus (*Myrmentoma*) *caryae discolor clarithorax* Emery.[10]—Localities: Waukegan, Ill.; Lakeside, Mich.; Ogden Dunes, Ind.

Camponotus castaneus Latreille.—This attractive species nests in logs and the soil under them in the black oak woods of the dunes. The colonies are of moderate size.

Localities: Momence, Ill. (Lowrie, Gregg); Dune Acres, Ind.; Beverly Shores, Ind. (Dybas).

Camponotus castaneus americanus Mayr.—According to the few data obtained, this ant inhabits moist oak forests on clay.

Localities: Palos Park, Ill.; Hadley, Ill.

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[10] *Camponotus* (*M.*) *caryae discolor* Buckley, another addition for the region, was collected in a dune heath at Waukegan, Illinois. Differs from *clarithorax* in having the head and thorax both bright red.

Camponotus herculeanus pennsylvanicus De Geer.—This is the ubiquitous "carpenter ant" that attacks live trees as well as all but the final stages of log decay. The wood is chewed and excavated probably by the worker majors or soldiers, and is deposited outside the nest as sawdust. Their food consists in large measure of the excretions of aphids, and is sought by the medium and small sized workers foraging over the leaves and twigs of trees. Incipient colonies containing a dealated female and her brood or first workers (very small) are frequently revealed when the loose bark of a fallen tree is removed. All forested zones about Chicago yielded specimens, and occasionally the ant may invade houses.

Localities: Palos Park, Ill.; New Lenox, Ill.; Momence, Ill.; La Salle, Ill. (Miller); Tonica, Ill. (Lowrie); Miller, Ind.; Ogden Dunes, Ind.; Dune Acres, Ind.; Chesterton, Ind.; Smith, Ind.; Lakeside, Mich.; Three Rivers, Mich.

Camponotus herculeanus pennsylvanicus ferrugineus Fabricius.—The red of this variety contrasts strikingly with the deep black of the typical *pennsylvanicus*. It is a much less common ant and is found primarily in rich, shady woods. Its preference seems to be for middle and late periods in rotting logs and stumps.

Localities: Orland Park, Ill.; Hadley, Ill.; Smith, Ind.; Lakeside, Mich.

Camponotus herculeanus ligniperda noveboracensis Fitch.—The species surpassed *pennsylvanicus* in the variety of niches occupied, yet was not as frequently encountered. While *pennsylvanicus* reaches into the Gulf States, *noveboracensis* overlaps its distribution only in the Northern States, and is said to live at somewhat higher elevations than the former. This may account in part for our records of the ant from tamarack bogs, which are boreal in character.

Localities: New Lenox, Ill.; Volo, Ill.; Miller, Ind.; Dune Acres, Ind.; "Indiana Dunes," Morocco, Ind. (Seevers); Smith, Ind.

POSTSCRIPT

Since this paper went to press, two more species have been found, namely: *Formica* (*Proformica*) *neogagates neogagates morbida* Wheeler and *F.* (*P.*) *neogagates neogagates vinculans* Wheeler. With the eighty-five species listed in Table I, plus the five additional accounted for here and in the footnotes, there are ninety forms which have been examined. Added to this, the five ants recorded by Talbot, but not represented in my collection, bring a total of ninety-five species (including subspecies and varieties) which are known to occur in the Chicago Region.

Dr. Creighton has recently revised the forms of *Formica rufa* in which varieties are eliminated and four new subspecies are described, et cetera.[11] Unfortunately, it is impractical to incorporate such changes into the present report, but the writer is in agreement with them, and no doubt similar revisions in other groups of *Formica* would be a distinct advance.

[11]Creighton, W. S. 1940. A revision of the North American variants of the ant *Formica rufa*. Amer. Mus. Nov. No. 1055, pp. 10.

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CORRECTIONS (ERRORS AND OMISSIONS)

Corrections are limited to critical omissions and serious errors.—The Editors.

Ewing and **Fox.** Book Notice, p. 336. Vol. 36, 1943. Publications on American Fleas were by Baker 1904, not "Parker" and Jellison. Fox wrote on "Fleas of Eastern United States" not "Western United States."

Rau, Phil. 1943. The nesting habits of certain Sphecid wasps of Mexico. Annals 36 (4): 652. In the heading, *Macrosiagon* sp. probably *excavatum*, near bottom of page 652, delete the words "sp. probably." Additional specimens sent recently to Mr. H. S. Barber have definitely established the beetle's identity as *M. excavatum* Champion.

MAILING DATES FOR 1944 ISSUES OF ANNALS

March Number—April 10, 1944.
June Number—July 7. 1944.
September Number—October 30, 1944.
December Number—January 19, 1945.

THE ENTOMOLOGICAL SOCIETY OF AMERICA

LIST OF MEMBERS

(MARCH, 1944)

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A

'39. Aamodt, T. L., State Entomologist's Office, University Farm, St. Paul, Minn.
'39. Ackermann, Otto, 639 Walnut St., Irwin, Pa. *Lepidoptera.*
'27. ADAMS, C. F., State Board of Health, Jefferson City, Mo. (F. '29). *Diptera.*
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'10. ALEXANDER, CHARLES P., Massachusetts State College, Amherst, Mass. (F. '20). *Tipulidae.*
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'13. ALLEE, W. C., Zool. Bldg., Univ. Chicago, Chicago, Ill. (F. '39). *Behavior.*
'25. ALLEN, H. W., Box 150, Moorestown, New Jersey, (F. '40). *Tachinidae, Tiphiidae.*
'42. Allen, Theodore, 2520 Mulberry Avenue, Muscatine, Iowa.
'32. Amos, John M., 204 Agri. Education Bldg., Penn. State College, State College, Pennsylvania. *Coccidae, Cerambycidae.*
'30. Anderson, Edwin J., Frear Laboratory, State College, Pa. *Beekeeping.*
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'37. Anderson, William H., Rm. 429, U. S. National Museum, Washington, D. C. *Coleopterous larvae.*
'39. Andre, Floyd, Office of Experiment Stations, U. S. D. A., Washington, D. C. *Thysanoptera.*
'37. Anduze, Pablo J., Instituto Nacional de Higiene, Ministerio de Sanidad y Asistencia Social, Caracas, Venezuela. *Culicidae.*
'32. ANNAND, P. N., Bureau of Entomology and Pl. Quar., Washington, D. C. (F. '39). *Aphids.*
'28. App, Bernard A., Box 316, Burgow, N. C. *Economic Entomology.*
'40. Archer, 2nd Lt. Allan F., Surgeon's Office, Camp Hdqts., Camp Van Dorn, Mississippi. *Arachnida.*
'23. Armstrong, T., Ent. Lab., Vineland Station, Ontario, Canada. *Scarabaeidae.*
'36. Ashton, Donald F., 2711 Van Dyke Ave., Raleigh, N. C. *Culicidae.*
'37. Assmuth, Rev. Joseph, Fordham University, New York, N. Y. *Isoptera.*
'42. Atkins, Edward L., Jr., Route 1, Smithshire, Illinois.
'34. Au, Sung Hin, P. O. Box 3319, Honolulu, Hawaii. *Aphids.*
'29. Audant, Andre, S. N. P. A., Port-au-Prince, Haiti. *Chrysomelidae.*
'33. AVINOFF, A., Carnegie Museum, Pittsburgh 13, Pa. (F. '39). *Lepidoptera.*

B

'37. Babers, Lt. Col. Frank H., 58 A.A.A. Brigade, Fort Bliss, Texas. *Physiology.*
Ch. *BACK, E. A., Bur. Ent. and Pl. Quar., Washington, D. C. (F. '38). *Asilidae, Aleyrodidae.*
'39. Badertscher, A. Edison, 103 Bonnie Hill Road, Burnbrae Towson, Md. *Insecticides.*

'21. BAERG, W. J., Univ. Arkansas, Fayetteville, Ark. (F. '32). *Poisonous Arthropods.*
'30. *Bailey, J. W., 27 Willway Road, Richmond, Va. *Myriapoda.*
'11. BAKER, A. C., Laboratorio Entomologico, Calzada Tacuba 295, Colonia Anahuac, Mexico, D. F., Mex. (F. '29). *Aphididae, Aleyrodidae.*
'43. Baker, Edward W., Laboratorio Entomologico, Apartado 3, Colonia Anahuac, D. F., Mexico.
'22. Baker, Howard, 5201 Oakland Ave., St. Louis, 10, Mo. *Apple and Pecan Insects.*
'36. Baker, Walter C., Health Center Bldg., Corpus Christi, Texas. *Toxicology.*
'28. Balch, R. E., Dom. Ent. Lab., Fredericton, New Brunswick, Canada. *Forest Insects.*
'20. BALDUF, W. V., 308 Entomology Bldg., Univ. of Illinois, Urbana, Ill. (F. '40). *Entomophagous insects.*
'43. Balock, John W., Laboratorio Entomologico, Apartado 3, Colonia Anahuac, D. F., Mexico.
'38. Ballou, Charles H., Estacion Experimental de Agricultura y Zootecnio, El Valle, Distrito Federal, Venezuela. *Economic Entomology.*
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'37. Barber, George W., 274 Dwight St., New Haven, Conn. *Corn earworm.*
Ch. BARBER, H. G., 143 E. Third Ave., Roselle, N. J. (F. '30). *Hemiptera.*
Ch. BARBER, H. S., U. S. National Museum, Washington, D. C. (F. '28). *Coleoptera.*
'23. Bare, Clarence O., Box 7062, Richmond 21, Va. *Notonectidae.*
Ch. Barlow, John, State College, Kingston, Rhode Island. *Corrodentia.*
'26. BARNES, J. F., Rothamsted Exp. Sta., Harpenden, Herts, England. (F. '37). *Cecidomyiidae.*
'28. Barnes, O. L., 1104 Ash Ave., Tempe, Arizona. *Hemileuca, Anastaxus.*
'43. Barnes, Ralph C., U. S. Public Health Service, 15 Pine St., New York 5, N.Y.
'40. Barnett, 2nd Lt. Herbert C., Sn. C., 10418-106th St., Ozone Park, Long Island, N. Y.
'39. Barrett, John P., care of Armour and Co., Chemical Research Dept., Union Stock Yards, Chicago 9, Ill. *Calliphoridae.*
'41. Barrett, Lt. Paul H., Station Hospital, Camp Adair, Ore. *Aquatic Insects.*
'35. Barrett, W. L., Jr., Box 509, Uvalde, Texas. *Diptera.*
'39. Bartlett, Lawrence M., Old Court House Annex, care of Farm Bureau, Mineola, N. Y. *Ephemeroptera.*
'18. BASINGER, A. J., Citrus Exp. Sta., Riverside, Calif. (F. '41). *Calliphoridae.*
'31. BATES, MARSTON, The Rockefeller Foundation, Apartado 2508, Bogota, Colombia, (F. '40). *Diptera, Trypetidae.*
'24. BEAMER, RAYMOND H., 1000 Missouri St., Lawrence, Kansas. (F. '34). *Homoptera, Cicadellidae.*
'34. Beck, Elmer W., 626 Virginia Ave., Toledo 10, Ohio. *Parasites European Corn Borer.*
'29. Bedard, W. Delles, 335 Giannini Hall, Univ. California, Berkeley, Calif. *Scolytidae, Braconidae.*
'20. Bedford, Hugh W., Gov't Ent., Agri. Research Serv., Ent. Sect., Wad Medani, Sudan, Africa.
'43. Beebe, Wm., New York Zoological Society, Zoological Park, Bronx Park, New York, N. Y.
'42. Belkin, 1st Lt. John N., 18th Malaria Survey Unit, NOPE Staging Area, New Orleans, La.
'25. BELL, ERNEST, 150-17 Roosevelt Ave., Flushing, N. Y. (F. '40). *Hesperiidae.*
'40. Benesh, Bernard, P. O. Box 159, North Chicago, Ill. *Lucanidae.*
Ch. Bentley, G. M., 64 Biology Bldg., Univ. Tenn., Knoxville 16, Tenn. *Orthoptera.*
'23. Benton, Curtis, 1216 Ball St., Lafayette, Indiana.
'17. *BEQUAERT, JOSEPH C., Harvard Med. Sch., Boston, Mass. (F. '34). *Vespidae, Tabanidae.*
'28. Berley, J. A., Div. Ent., Clemson College, So. Carolina. *Coccidae, Odonata.*
'43. Berner, Major Lewis, 0461681, Hq. Africa Middle-East Wing, A. T. C., A. P. O. 625, care of Postmaster, Miami, Florida.

'39. Berry, Paul A., Blanca del Tabare 2980, Montevideo, Uruguay. *Biological Control.*
'34. Bess, Henry A., 56 Hillhouse Ave., New Haven, Conn. *Ecology.*
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'38. *Bickley, Wm. E., Jr., U. S. Public Health Service, 300 Essex Bldg., Norfolk 10, Va. *Chrysopidae.*
'25. Bigger, J. H., Room 129, Natural Resources Bldg., Nat. History Survey, Urbana, Ill. *Plant Resistance to Insect Attack.*
'30. Billings, Samuel C., 8407 Woodcliff Court, Silver Spring, Md. *Mothproofing.*
'13. BILSING, S. W., College Station, Texas. (F. '41). *Cerambycidae.*
Ch. BIRD, HENRY, 600 Milton Road, Rye, N. Y. (F. '30). *Noctuidae, Papaipema.*
Ch. BISHOPP, F. C., Bur. Ent. & Pl. Quar., Washington, D. C. (F. '28). *Ixodoidea, Siphonaptera, Anoplura.*
'24. BISHOPP, SHERMAN C., Dept. Biol., University Rochester, Rochester, N. Y. (F. '43). *Arachnida.*
'25. Bissell, Theo. L., Experiment, Georgia. *Aphididae, Curculionidae.*
'37. Blackburn, Norris D., Ohio Agri. Exp. Station, Wooster, Ohio. *Chrysomelidae.*
Ch. BLAISDELL, F. E., Sr., California Academy of Sciences, Golden Gate Park, San Francisco, Calif. (F. '24). *Tenebrionidae, Melyridae.*
'28. Blanchard, R. A., Box 32, Urbana, Illinois. *Plant resistance to insect attack.*
'32. Blanton, Franklin S., P. O. Box 786, Babylon, L. I., N. Y. *Trypetidae, Otitidae.*
'30. Blauvelt, Helen Hayden, care of Wm. Savey, Lake Rd., Ithaca, N. Y.
'28. Blauvelt, Wm. E., Comstock Hall, Cornell Univ., Ithaca, N. Y.
'37. Bleasdale, Gale Gates, Tipton, Iowa. *Rynchophora.*
'29. BOESEL, M. W., R. R. No. 2, Oxford, Ohio. (F. '43). *Chironomidae.*
'37. Bohart, Richard M., Div. of Ent., Univ. Calif., 405 Hilgard Ave., Los Angeles, Calif. *Strepsiptera, Hymenoptera.*
'28. BORROR, DONALD J., Dept. of Zool. and Ent., Ohio State Univ., Columbus, Ohio. (F. '43). *Odonata.*
'14. BOVING, ADAM G., U. S. Nat. Museum, Washington, D. C. (F. '29, H. F. '41). *Coleopterous larvae.*
'42. Bowery, Thomas G., 214 Birmingham Ave., Avalon, Pgh. 2, Pa.
'33. Boyce, A. M., Citrus Exp. Sta., Riverside, Calif.
Ch. BRADLEY, J. C., Cornell Univ., Ithaca, N. Y. (F. '14). *Campsomeris, Vespidae, Scoliidae.*
'19. BRADLEY, G. H., Box 654, New Smyrna Beach, Fla. (F. '41). *Diptera, Culicidae.*
'37. Bradley, Wm. G., Box 576 M. O., Toledo, Ohio. *Parasitic Hymenoptera.*
'23. Branch, Hazel E., Univ. of Wichita, Wichita, Kansas. *Chironomidae larvae.*
'25. Brandhorst, Carl T., 106 Lincoln St., Seward, Nebraska. *Wasps.*
Ch. BRAUN, ANNETTE F., 2702 May St., Cincinnati 6, Ohio. (F. '24). *Microlepidoptera.*
'26. BREAKEY, E. P., Western Washington Exp. Sta., Puyallup, Wash. (F. '43). *Cicadellidae.*
'37. Breland, Osmond P., Dept. Zoology, University of Texas, Austin, Texas. *Chalcidoidea.*
'29. Brindley, T. A., Box 73, Moscow, Idaho. *Pea Weevil.*
'26. BRITTAIN, W. H., McDonald College P. O., Quebec, Canada (F. '37). *Homoptera.*
'20. BROMLEY, STANLEY W., High Ridge Road, Stamford, Connecticut. (F. '37). *Asilidae.*
'40. Brookman, Bernard, 1728 N. W. 32nd Ave., Portland 10, Oregon. *Diptera.*
'41. Brooks, Ivan C., Dept. of Entomology, Purdue Univ., Lafayette, Indiana. *Diptera.*
'39. Brower, Auburn E., 5 Hospital St., Augusta, Maine. *Lepidoptera, Catocala.*
'33. Brown, F. Martin, Fountain Valley School, Colorado Springs, Colo. *Pieridae of the Americas.*
'42. Brown, John H., University of Alberta, Edmonton, Alberta. Canada.

'26. BROWN, W. J., Ent. Branch, Dept. Agri., Ottawa, Canada. (F. '40). *Coleoptera.*
Ch. BRUES, C. T., Biological Laboratory, Harvard University, Cambridge, Mass. (F. '14). *Hymenoptera.*
'30. BRUNER, S. C., Estacion Agronomica, Santiago de las Vegas, Havana, Cuba. (F. '37). *Homoptera, Hemiptera of Cuba.*
'33. BRYANT, ELIZABETH B., Mus. Comp. Zool., Cambridge, Mass. (F. '43). *Arachnida.*
'30. Bryant, Owen, Steamboat Springs, Colo. *Coccinellidae.*
'38. Bryce, P. I., Entomological Lab., Vineland Station, Ontario, Canada. *Fruit Tree Insects.*
'27. Buckell, E. R., Field Crop Insect Laboratory, P. O. Bldg., Kamloops, Brit. Col., Canada. *Orthoptera, Odonata.*
Ch. *BUENO, J. R. DE LA TORRE, 311 E. 4th St., Tucson, Ariz. (F. '28). *Aquatic Hemiptera, Heteroptera.*
'31. Bugbee, Robert E., Dept. Zoology, Indiana University, Bloomington, Ind. *Eurytomidae.*
'38. Bunn, Maj. Ralph W., 1st Med. General Lab., A. P. O. 519, care of Postmaster, New York, N. Y. *Fulgoridae, Curculionidae.*
Ch. BURGESS, A. F., 20 Sanderson St., Greenfield, Mass. (F. '17). *Carabidae.*
'35. Burks, Capt. B. D., Nat. History Survey, Rm. 231, Natural Resources Bldg., Urbana, Ill. *Chalcididae.*
'27. *Burrell, R. W., care of Mrs. L. E. Burrell, P. O. Box 1049, Orlando, Fla. *Thynnidae, Tiphiidae.*
'29. Bushey, Clinton J., Olivet Nazarene College, Kankakee, Ill. *Curculio.*
'33. Bushnell, Ralph J., Univ. of Connecticut, Storrs, Conn. *Conopidae.*
'35. Bussart, J. Everett, 425 East Illinois St., Wheaton, Ill. *Tachinid Biology.*
'30. BUTT, F. H., Cornell Univ., Ithaca, N. Y. (F. '40).
'20. Buys, John L., Dept. Biol., St. Lawrence Univ., Canton, N. Y. *Homoptera, Cicadellidae.*
'36. Buzicky, Capt. Albert W., 512 Montrose Lane, St. Paul, Minn. *Chyphotes.*
'24. BYERS, C. FRANCIS, Dept. Biol., Univ. Fla., Gainesville, Fla. (F. '41). *Odonata.*

C

'25. Caffrey, D. J., Bur. Ent. & Pl. Quar., Washington 25, D. C.
'35. *Caldwell, John S., 535 So. Court St., Circleville, Ohio. *Fulgoridae, Psyllidae.*
'43. Callan, E. McC., Imperial College of Tropical Agri., Trinidad, B. W. I.
Ch. CALVERT, PHILIP P., P. O. Box 14, Cheyney, Pa. (F. '07, H. F. '39). *Odonata.*
'28. CAMPBELL, FRANK LESLIE, Am. Assoc. Advancement Science, Smithsonian Inst. Bldg., Washington 25, D. C. (F. '34). *Toxicology.*
'13. CAMPBELL, ROY E., 1208 E. Main, Alhambra, California. (F. '41).
'14. *Capp, S. B., Box 2054, Philadelphia, Penn.
'40. Capps, Hahn W., Div. of Insect Identification, U. S. Nat. Mus., Washington, D. C. *Geometridae.*
'33. CARPENTER, F. M., Mus. Comp. Zool., Harvard Univ., Cambridge, Mass. (F. '38). *Mecoptera, Neuroptera.*
'26. Carpentier, Fritz, Inst. Ed. Van Veneden, 10 Rue Vivegnis, Leige, Belgium. *Morphology.*
'31. Carruth, Laurence A., Div. of Entomology, New York Agri. Exp. Station, Geneva, N. Y. *Meloidae.*
'22. CARTER, WALTER, P. O. Box 3166, Honolulu, T. H. (F. '38). *Insect Transmission of Plant Diseases.*
'26. CARTWRIGHT, O. L., Agri. Exp. Station, Clemson, S. C. (F. '41). *Scarabaeidae.*
'26. Cartwright, William B., Box 495, Lafayette, Indiana. *Hessian Fly.*
'29. Cendana, S. M., Agricultural College, Laguna, P. I. *Coccinellidae.*
'41. Chamberlain, Roy W., Dept. of Entomology, Montana State College. Bozeman, Mont. *Collembola.*
'22. CHAMBERLAIN, JOSEPH C., P. O. Box 278, Forest Grove, Oregon. (F. '38). *Chelonethida.*
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'28. COLE, 2ND LT. ARTHUR C., JR., O-577167, A. P. O. 12218-B, care of postmaster, New York, N. Y. (F. '43). *Formicidae.*
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'29. Conklin, J. G., Dept. Ent., Univ. N. H., Durham, N. Hampshire. *Coccinellidae.*
'35. Connell, 1st Lt. Walter A., West Grove, Pa. *Diptera.*
'41. Cook, Margaret L., 726 E. Adams Blvd., Los Angeles 11, Calif. *Sphecoidea, Vespoidea.*
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'36. Cooper, James Furman, Univ. Exs. Farm, Kearneysville, W. Va. *Pear Psylla.*
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'37. Dorst, Major Howard E., 1535½ Parkway Ave., Salt Lake City, Utah. *Cicadellidae.*
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'38. Emerson, Lt. K. C., Fort William McKinley, Rizal, P. I. *Mallophaga.*
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'30. Glover, Louise Haas, Box 486, T. Hall, Durham, N. H. *Carabidae.*
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'27. HINMAN, E. HAROLD, Apartado 23 bis, Mexico, D. F. (F. '37). *Culicidae.*
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'20. HOFFMANN, WM. E., Lingnan Univ., Canton, China. (F. '39). *Hemiptera.*
'35. Holway, Ensign Richard T., South Duxbury, Mass. *Termites.*
Ch. HOOD, J. DOUGLAS, Dept. Ent., Cornell Univ., Ithaca, N. Y. (F. '32). *Thysanoptera.*
'38. Hoogstraal, Harry, 303 Entomology Bldg., Univ. of Ill., Urbana, Ill. *Morphology.*
'34. HORSFALL, WILLIAM R., Dept. Ent., Univ. of Arkansas, Fayetteville, Ark. (F. '43). *Culicidae.*
'34. Hoskins, W. M., 112 Agri. Hall, Univ. of Calif., Berkeley, Calif. *Physiology.*
'24. Hough, W. S., Winchester, Virginia. *Apple Insects.*
Ch. HOUSER, J. S., Agri. Exp. Sta., Wooster, Ohio. (F. '31). *Coccidae.*
'39. Hovey, Charles L., Aroostook Farm, Presque Isle, Maine. *Aphiidae.*

Ch. HOWARD, L. O., Bur. Ent. & P. Q., Washington, D. C., (F. '07, H. F. '24). *Chalcidoidea.*
'14. Howard, Neale F., 151 West 11th Ave., Columbus, Ohio. *Mexican Bean Beetle.*
'43. Howe, 1st Lt. Wayne L., Sn. C., care of Mrs. W. L. Howe, 928 Park Ave., Ft. Lupton, Colo.
'39. Howland, A. F., 1208 E. Main St., Alhambra, California. *Tomato Insects.*
'23. HUBBELL, THEO. H., Dept. Biology, Univ. of Florida, Gainesville, Fla. (F. '39). *Orthoptera.*
'20. HUCKETT, H. C., Long Is. Vegetable Res. Farm, Riverhead, L. I., N. Y. (F. '38). *Muscidae.*
'39. Hughes, John H., U. S. Quarantine Station, New Orleans (Algiers), La. *Chrysomelidae.*
'16. HUNGERFORD, H. B., 323 Snow Hall, Univ. Kans., Lawrence, Kans. (F. '27). *Aquatic Hemiptera.*
'43. Hunt, Charles R., Box 62A, Dryden, Washington.
'36. Hurlbut, Lt. Herbert S., care of C. S. Hurlbut, West High St., Union City, Pa. *Culicidae.*
'38. Hutson, Ray, Dept. of Entomology, Michigan State College, E. Lansing, Mich. *Insecticides.*
'42. Hutzel, John M., Dept. Zool. & Ent., Ohio State Univ., Columbus, Ohio.
'08. HYSLOP, JAMES A., Arsenal, Silver Spring, Maryland, (F. '35). *Elateridae.*

I

'31. IDE, F. P., Dept. Zool., Univ. Toronto, Toronto 5, Ont., Canada. (F. '40). *Ephemeroptera.*
'19. *ILLINGWORTH, J. F., Bishop Museum, Honolulu, Hawaii. (F. '40). *Muscoidea.*
'28. Ingram, J. W., Box 387, Houma, La. *Sugarcane Insects.*
'14. ISELY, DWIGHT, Box 3, University Station, Fayetteville, Ark. (F. '34). *Chrysomelidae, Curculionidae.*
'36. Isely, F. B., 2835 W. Gramercy, San Antonio, Texas. *Orthoptera.*
'22. Ishimori, Naoto, Faculty Agri., Imp. Univ., Hongo, Tokyo, Japan. *Silkworm Diseases.*
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*
'34. Ivy, Edward E., Box 1218., Waco, Texas.

J

'41. James, Brother Cyprian, Manhattan College, Spuyten Duyvil Pkwy., New York 63, N. Y. *Psyllidae.*
'38. James, Freburn L., Box 327, Saranac, Michigan. *Coleoptera.*
'31. JAMES, MAURICE T., Dept. of Ent., Colo. State College, Ft. Collins, Colo. (F. '40). *Stratiomyiidae.*
'30. Janes, Melvin J., Texas Experiment Station, Alta Loma, Texas. *Economic Entomology.*
'35. Jaques, Harry E., 709 N. Main, Mount Pleasant, Iowa. *Insect Ecology.*
'30. Jaynes, H. A., 117 Chatham St., Chatham, N. J. *Tiphia of S. A.*
'25. JEANNEL, RENE, Mus. d'Histoire Naturelle, 45 bis rue de Buffon, Paris 5e, France. (F. '30). *Trechus, Anophthalmes.*
'10. Jennings, H. R., High School of Com., Hayes & Van Ness Ave., San Francisco, Calif. *Diptera.*
'41. Jensen, Dilworth D., Univ. of Hawaii, Agr. Exp. Sta., Honolulu, T. H.
'15. Jewett, H. H., Agri. Exp. Sta., Lexington, Ky. *Tobacco and Forage Crop Insects.*
'43. Jodka, Joseph F. T., Comstock,Hall, Cornell Univ., Ithaca, N. Y.
Ch. JOHANNSEN, O. A., 203 Parkway, Ithaca, N. Y. (F. '14, H. F. '39). *Diptera.*
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'39. Johnson, John W., 111 N. Yale Ave., Fullerton, Calif. *Saturniidae.*
'26. Johnston, H. G., P. O. Box 751, Phoenix, Arizona. *Miridae, Hemiptera.*
'27. Jones, Elmer T., 1204 Fremont, Manhattan, Kansas. *Hessian Fly.*
Ch. Jones, Frank M., 2000 Riverview Ave., Wilmington, Delaware. *Psychidae.*

'39. Jones, J. R. J. Llewellyn, "Arranmore," R. M. D. No. 1, Cobble Hill, British Columbia, Canada. *Ecology of Lepidopterous Larvae.*
'41. Jones, Joseph W., Jr., P. O. Box 173, Newbern, Tennessee.
'40. Just, Theodore K., P. O. Box 126, Notre Dame, Indiana.

K

'42. Kadner, Lt. Carl G., Malaria Survey Units, A. S. F., UTC., N. O. S. A., New Orleans 12, La. *Hippoboscidae, Culicidae.*
'34. Kagy, J. Franklin, care of Dow Chemical Co., P. O. Box 245, Seal Beach, Calif. *Insect Toxicology.*
'26. Kamal, Mohammed, Parasite Laboratory, Cotton Research B., Giza, Egypt. *Cotton Insects.* (Annals and Statements to be sent to A. Moursi, Citrus Exp. Station, Riverside, Calif.).
'34. Kearns, Clyde W., Dept. Ent., Univ. of Illinois, Urbana, Ill. *Insecticides.*
'29. Keck, Capt. Chester B., Box 340, Honolulu, Hawaii. *Ecology.*
'14. KENNEDY, C. H., Dept. Zool. and Entomology, Ohio St. Univ., Columbus 10, Ohio. (F. '27). *Odonata, Ants.*
'36. Kessel, Berta B., 35 Elaine Ave., Mill Valley, Calif.
Ch. Kincaid, Trevor, Univ. Wash., Seattle, Washington. *Psychodidae, Dytiscidae.*
'12. KING, J. L., Box 150, Moorestown, New Jersey. (F. '32). *Biological Control.*
'23. KING, KENNETH M., Dominion Entomolgoical Laboratory, Saskatoon, Sask., Canada. (F. '38). *Elateridae Larvae, Noctuidae.*
'28. KING, WILLARD V., Fourth Corps Area Laboratory, Ft. McPherson, Ga. *Culicidae.* (F. '38).
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'38. Klots, Alexander B., Biology Dept., 17 Lexington Ave., New York, N. Y. *Lepidoptera.*
'11. KNIGHT, H. H., Dept. Zool., St. College, Ames, Iowa. (F. '28). *Hemiptera, Miridae.*
'40. Knight, Kenneth L., 121 Wesley St., Wheaton, Ill. *Geometrid Larvae.*
'24. KNOWLTON, GEORGE F., Agri. Exp. Sta., Logan, Utah. (F. '40). *Aphididae.*
'32. KNULL, MRS. DOROTHY, 330 E. Dunedin Rd., Columbus 2, Ohio. (F. '43). *Erythroneura.*
'34. KNULL, JOSEF N., Dept. Zool. & Ent., Ohio State Univ., Columbus 10, Ohio. (F. '43). *Cleridae, Elateridae, Buprestidae, Cerambycidae.*
'37. Knutson, Herbert C., U. S. P. H. S., 605 Volunteer Bldg., 66 Luckie St., Atlanta, Ga. *Noctuidae.*
'17. Kraatz, Walter C., Univ. Akron, Akron, Ohio.
'42. Krafchick, Bernard, care of Mrs. B. Krafchick, 578 Greene Ave., Brooklyn, N. Y.
'41. Kramer, Sol, 9 Campus Place, Brooklyn, N. Y.
'40. Kretzschmar, Lt. (jg) Gerhard, 6807 Ridge Boulevard, Brooklyn, N. Y.
'34. Krombein, Karl Von Vorse, Division of Insects, U. S. Nat. Mus., Washington, D. C. *Aculeate Hymenoptera.*
'41. Kuitert, Louis C., 706 Florence St., Kalamazoo, Mich. *Nepidae, Gerridae.*
'36. Kulash, Walter M., Dept. Zool. & Ent., North Carolina State College, Raleigh, N. C. *Collembola.*

L

'28. Lamiman, J. F., 2244 Summer St., Berkeley 7, Calif. *Acarina.*
'30. LANDIS, B. J., P. O. Box 218, Union Gap, Washington. (F. '40). *Biological Control.*
'42. Lane, John, Instituto de Higiene de Sao Paulo, Caixa Postal 99B, Sao Paulo, Brazil.
'40. Lange, W. Harry, Jr., Univ. of California, Court House, P. O. Box 1370, Salinas, Calif. *Lepidoptera.*
'25. Langford, George S., Dept. Ent., Univ. Maryland, College Park, Md. *Economic Entomology.*
'17. Langston, James M., A. & M. College, Miss. *Phyllophaga.*
'37. La Rivers, Ira, Box 1493, Reno, Nevada. *Odonata Psychodidae.*

'14. Larrimer, W. H., U. S. D. A. Forest Service, Washington, D. C. *Cicadellidae.*
'38. Larson, N. P., Hulmeville, Pa. *Physiology.*
'37. Lassman, G. W., Bravo No. 12, Jalapa, Vera Cruz, Mexico. *Culicidae.*
'13. LATHROP, F. H., Agric. Exp. Station, Orono, Maine. (F. '41). *Cicadellidae.*
'40. Latta, Randall, Bur. Ent. & P. Q., Washington, D. C. *Toxicology.*
'23. Lauderdale, J. L. E., P. O. Box 2006, Phoenix, Arizona.
'17. LAWSON, PAUL B., 2215 Vermont St., Lawrence, Kans. (F. '31). *Cicadellidae.*
'39. Leech, H. B., P. O. Box 308, Vernon, British Columbia, Canada. *Coleoptera.*
'12. LEIBY, R. W., Comstock Hall, Cornell Univ., Ithaca, N. Y. (F. '40). *Embryology.*
'38. Leonard, Justin W., Hunt Creek Exp. Sta., P. O. Box 5, Lewiston, Mich. *Aquatic Insects.*
'28. Leonard, Mortimer D., 2480 16th St. N. W., Washington, D. C. *Aphididae.*
'34. Le Veque, Norma, 2135 Fourth St., Boulder, Colo. *Apoidea.*
Lewis, Mrs. W. M., Division of Entomology, University of California College of Agri., Davis, Calif.
'33. Lilly, John H., King Hall, Univ. of Wis., Madison 6, Wis. *Coleophoridae.*
'34. Lindgren, David L., Univ. of Calif., Citrus Exp. Sta., Riverside, Calif. *Toxicology.*
'39. Lindquist, Arthur W., Box 3391, Orlando, Fla. *Chironomidae.*
'17. LINDSEY, A. W., Box 612, Granville, Ohio. (F. '40). *Hesperioidea.*
'33. *LINSLEY, E. GORTON, 112 Agricultural Hall, University of California, Berkeley, Calif. (F. '41). *Cerambycidae of World Coleoptera of N. Am.*
'25. LIST, GEO. M., Agri. College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'30. Livingston, E. M., 0-502994, Hq. 7th Army, A. P. O. 758, care of Postmaster, New York, N. Y.
'31. Lloyd, Llewellyn, University, Leeds, England.
'19. Lobdell, Mrs. Gladys H., Rt. 2, Brevard, N. C. *Coccidae.*
'30. Loftin, U. C., Bureau Entomology & P. Q., Washington, D. C.
'38. Ludwig, Daniel, Dept. of Biology, N. Y. Univ., 181st St. and Univ. Ave., New York 53, N. Y. *Physiology.*
'13. LUGINBILL, PHILIP, Box 495, Lafayette, Ind. (F. '41). *Phyllophaga.*
'34. Lund, Lt. (jg) Horace O., Naval Air Station, (LTA) Weeksville, Elizabeth City, N. C. *Culicidae.*
'31. Lyle, Clay, State College, Miss. *Crustacea.*
'40. Lyman, F. Earle, care of T. V. A., Norris, Tenn. *Aquatic Insects, Ephemeroptera.*

M

'43. Mackenzie, G. P., 1284 Sherwood Road, San Marino 9, Calif.
'32. MacLeod, Guy F., 1628 N. Fort Meyr Drive, Arlington, Va. *Physiology.*
'40. MacSwain, J. W., 2620 Stuart St., Berkeley, California.
'20. McBride, O. C., Box 340, Honolulu 9, Hawaii. *Insecticides.*
'43. McCall, George L., Dept. Ent., Dupont Exp. Station, Wilmington, Del.
'29. McClure, H. Elliott, 315 S. 17th St., Ord, Nebraska. *Ecology.*
'17. MCCRACKEN, ISABEL, Box 1545, Stanford University, Calif. (F. '39). *Apoidea.*
'10. McDaniel, Eugenia, Agri. College, East Lansing, Mich. *Coccidae, Orthoptera.*
'30. McGovran, E. R., Bureau of Ent. & Plant Quar., Nat. Agr. Res. Center, Beltsville, Md. *Toxicology.*
'11. MCINDOO, N. E., 7225 Blair Rd., Takoma Park, Washington 12, D. C. (F. '34). *Insect Physiology.*
'32. McKinstry, Arthur Porter, 320 Normandy, Modesto, Calif. *Microvelia.*

'32. Madden, A. H., Bur. Ent. & Plant Quar., Box 3391, Orlando, Fla. *Economic Entomology.*
'41. Maddock, Darrell R., 450 Cross St., Ogden, Utah.
'17. Maheux, Georges, Dept. Agri., Parliament Bldg., Quebec, Canada. *Forest Insects.*
'43. Maina, Bartholomew A., 10623 Church St., Chicago 43, Illinois.
'40. Mangrum, James F., Lincoln Memorial Univ., Harrogate, Tenn. *Acarina.*
'21. *Mank, Edith Webster, 12 Reservoir St., Lawrence, Mass. *Coleoptera.*
'21. Mank, Helen G., 12 Reservoir St., Lawrence, Mass.
'13. *MANN, WM. M., Nat. Zool. Park, Washington, D. C. (F. '37). *Formicidae.*

'23. Manter, Jerauld A., Agri. College, Storrs, Conn. *Economic Entomology.*
'37. Manzelli, Manlio, 25 Leland Ave., Plainfield, N. J. *Hemiptera.*
'35. *Maple, John D., P. O. Box 47, Yokohama, Japan. *Physiology.*
'38. March, Ralph B., 376 Merritt, Oshkosh, Wis.
'22. Marcovitch, S., University Farm, Knoxville, Tenn. *Insecticides.*
'37. Markos, Basil G., 17 Mechanic St., Dover, New Hampshire. *Toxicology.*
Ch. MARLATT, C. L., 1521–16th St., N. W., Washington, D. C. (F. '07, H. F. '41). *Coccidae.*
Ch. MARSHALL, W. S., 139 E. Gilman St., Madison 3, Wis. (F. '17). *Morphology.*
'25. Martin, Chas. H., 4221-1/8 Burns, Los Angeles 27, Calif. *Ecology.*
'43. Martin, Esmond B., 465 E. 57th St., New York 22, N. Y.
'34. Martorell, Luis F., Agri., Exp. Station, P. O. Box, 614, Rio Piedras, Puerto Rico. *Sugar Cane, Forest Insects.*
'38. Marvin, Philip H., Box 150, Moorestown, N. J. *Biology of Melittobia.*
'21. Mason, Arthur C., Box 150, Moorestown, N. J. *Thysanoptera.*
'30. Mason, Horatio C., 298 Blenheim Rd., Columbus 2, Ohio. *Tomato Fruitworm.*
Ch. MATHESON, ROBT., Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Maxson, Asa C., P. O. Box 46, Longmont, Colo. *Aphidae.*
'36. Mead, Albert R., 1035 Franklin St., Santa Clara, Calif. *Chrysomelidae.*
'37. Medler, John T., 921 N. 3rd St., Albuquerque, N. M. *Cicadellidae.*
'25. Meiners, Edwin, Rm. 238, 6651 Enright, St. Louis 5, Mo. *Lepidoptera.*
'32. Melampy, R. M., Dept. Zool., Louisiana State Univ., Baton Rouge, La. *Physiology.*
Ch. MELANDER, A. L., 4670 Rubidoux Drive, Riverside, Calif. (F. '14). *Diptera.*
'27. Melvin, Roy, 5501 Willis, Dallas 6, Texas. *Physiology.*
'42. Mendall, Seaton C., Hammondsport, N. Y.
'33. Menusan, Henry, Jr., Div. of Extension, Penn. State College, State College, Pa. *Physiology, Ecology.*
'32. Merino, Gonzalo, Bureau Plant Industry, Manila, P. Is. *Cicadellidae.*
'23. Merrill, G. B., Plant Board, Seagle Bldg., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Dept. Entomology, Univ. Ill., Urbana, Ill. (F. '20). *Syrphidae.*
'39. Metcalf, Robert L., Health and Safety Dept., Tennessee Valley Authority, Wilson Dam, Ala. *Insect Physiology.*
'09. METCALF, Z. P., State College Station, Raleigh, North Carolina. (F. '34). *Homoptera.*
'35. MICHELBACHER, A. E., 112 Agri. Hall, Univ. of Calif., Berkeley, Calif. (F. '41). *Symphyla, Apoidea.*
'37. Michener, Charles D., Post Surgeon's Office, Camp Shelby, Miss. *Apoidea.*
'17. MICKEL, CLARENCE E., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '35). *Mutillidae.*
'36. Miller, Albert, Dept. Tropical Medicine, Tulane Univ., 1430 Tulane Ave., New Orleans, La. *Culicidae.*
'31. Miller, Albert C., Box 2038, Pittsburgh, Pa. *Membracidae.*
'42. Miller, E. Morton, Dept. Zoology, Univ. of Miami, Coral Gables, Fla.
'30. Miller, Forrest W., Biology Dept., Hartwick College, Oneonta, N. Y. *Aphididae.*
'37. Milliron, Herbert E., Dept. of Entomology, Purdue Agri. Exp. Station, Lafayette, Indiana. *Chalcidoidea, Bombidae.*
'29. MILLS, HARLOW B., Dept. of Ent., Montana State Coll., Bozeman, Montana. (F. '37). *Collembola.*
'37. Milne, Lorus J., Johnson Foundation, Univ. Penna., Philadelphia 4, Pa. *Trichoptera.*
'25. Milum, Vern G., 104 Exp. Zool. Lab., Univ. of Ill., Champaign, Ill. *Apiculture.*
'43. el Minchaoui, Ibrahim, P. O. B. 763, Cairo, Egypt.
'26. MINNICH, D. E., Dept. Zool., Univ. Minn., Minneapolis, Minn. (F. '39). *Behavior.*
'38. Miroyiannis, Stanley D., Dept. of Biology, Northeastern Univ., Boston, Mass. *Histology.*
'39. Mitchell, Robert T., Patuxent Research Refuge, Bowie, Md. *Ichneumonidae and Braconidae.*

'21. MITCHELL, T. B., State College, Raleigh, N. Carolina. (F. '37). *Apoidea, Megachile.*
'22. MONTGOMERY, B. ELWOOD, Dept. Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'39. Moore, Geo. A., 359 Querbes Ave., Outremont, Quebec, Canada. *Hemiptera.*
'39. Moore, Warren, Bon Air, Va. *Dermestidae.*
Ch. Morgan, H. A., University Library, Univ. of Tennessee, Knoxville, Tenn. Send mail to 2424 Kingston Pike, Knoxville, Tenn.
'27. Morgan, W. P., R. R. 6, Box 414, Indianapolis, Ind. *Dermaptera.*
Ch. MORRILL, A. W., 1505 Winchester Ave., Glendale, 1, Calif. (F. '39).
'12. MORRISON, HAROLD, Bureau of Entomology and Plant Quarantine, Washington, D. C. (F. '28). *Coccidae.*
'08. MOSHER, EDNA, R. R. No. 1, Newport, Nova Scotia, Canada. (F. '20). *Lepidoptera.*
'20. Mote, Don C., St. Agri. College, Corvallis, Oregon. *Economic Entomology.*
'29. MOULTON, DUDLEY, 35 Elwood St., Redwood City, Calif. (F. '31). *Thysanoptera.*
'15. MUESEBECK, C. F. W., Bureau of Entomology and Plant Quarantine. Washington, D. C. (F. '34). *Braconidae, Bethylidae.*
'36. Mulrennan, J. A., State Board of Health, Box 210, Jacksonville 1, Fla. *Culicidae.*
'43. Muma, Martin H., 4504 Guildford Rd., College Park, Md.
'27. *Munro, J. A., State College Station, Fargo, North Dakota. *Orthoptera, Diptera.*
'35. *Murray, William D., 4460 Rosemary Parkway, Columbus 2, Ohio. *Sphecidae.*
'28. MUSGRAVE, ANTHONY, Australian Museum, College St., Sydney, New South Wales, Australia. (F. '41). *Nycteribiidae.*
'27. Musgrave, Paul N., 1956 Underwood Ave., Huntington, W. Va. *Dryopidae.*

N

'35. Nagel, R. H., 420 Foster Ave., Coeur d'Alene, Idaho.
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07, H. F. '35). *Odonata, Ephemerida.*
'21. Neiswander, C. R., Ohio Agr. Exp. Sta,. Wooster, Ohio. *Insects of Ornamentals.*
'28. Neiswander, R. B., Agri. Exp. Sta., Wooster, Ohio. *Fruit Insects.*
'39. Nesbitt, Herbert H. J., 34 Lakeside Ave., Ottawa, Ontario, Canada. *Acarina.*
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa. *Economic Entomology.*
'34. Nevin, F. Reese, School of Hygiene and Pub. Health, Johns Hopkins Univ., 615 N. Wolfe St., Baltimore, Md. *Morphology of Acarina.*
Ch. Newcomer, E. J., Box 1291, Kakima, Washington. *Fruit Insects.*
'15. Newman, Geo. B., 246 E. Hamilton Ave., State Coll., Pa. *Insect Histology.*
'28. Newton, Richard C., Bureau of Ent. & Plant Quar., Bozeman, Montana. *Alfalfa Weevil.*
'38. Nicholson, H. Page, U. S. Public Health Service, 300 Essex Bldg., Norfolk 10, Va. *Simuliidae.*
'31. Nickels, C. B., Box 209, Bureau of Entomology, Brownwood, Texas. *Pecan Insects.*
'22. Noble, W. B., Bur. of Ent. & Pl. Q., Box 1857, Sacramento 9, Calif. *Hessian Fly.*
'38. Noland, Lowell E., Biology Bldg., Univ. of Wisconsin, Madison, Wis.
'17. *Notman, Howard, Circle Rd., Dougan Hills, Staten Island, N. Y. *Carabidae, Staphylinidae.*
'43. Nushawg, William N., 292 Sycamore St., East Aurora, N. Y.
'37. Nye, William P., care of Ray Whipple, St. George, Utah. *Forest Insects.*

O

'31. O'Byrne, Harold I., R. F. D. No. 1, Box 792, Glencoe, Mo. *Ecology Lepidoptera.*
'08. O'KANE, WALTER C., Durham, New Hampshire. (F. '24).
'29. OMAN, PAUL W., Bur. Ent. & P. Q., Washington, D. C. (F. '40). *Homoptera.*

'37. O'Neill, William J., Tree Fruit Branch Exp. Sta., Box 596, Wenatchee, Wash. *Fruit Insects.*
'34. Oosthuizen, M. J., School of Agriculture, Potchefstroom, South Africa. *Stored Grain Insects.*
Ch. OSBORN, HERBERT, Ohio St. Univ., Columbus 10, Ohio. (F. '07, H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., 1 Highland Ave., Los Gatos, Calif. *Cicadellidae.*
Ch. OSBURN, R. C., Ohio State Univ., Columbus 10, Ohio. (F. '17). *Syrphidae.*
'43. Osmun, Lt. John V., Medical Branch, Hdq. 2nd Serv. Command, Governors Island, New York 4, N. Y.
'20. Otanes, Faustino Q., Bureau of Plant Industry, Manila, Philippine Is. *Economic Entomology.*
'36. Owen, Wm. Bert, Dept. of Zool., Univ. of Wyoming, Laramie, Wyo. *Culicidae.*
'25. OZBURN, REG. H., Ont. Agri. College, Guelph, Ontario, Canada. (F. '43). *Insect Histology.*

P

'15. Packard, Clyde M., Bureau of Ent. & Plant Quar., Washington, D. C. *Cereal and Forage Insects.*
'18. Painter, H. R., 705 Bexley Road, West Lafayette, Indiana. *Phyllophaga.*
'19. PAINTER, R. H., Dept. Ent., K. S. C., Manhattan, Kansas. (F. '35). *Diptera, Bombyliidae.*
'39. Palm, Charles E., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Forage Crop Insects.*
'37. Palmer, Boyd B., Polytechnic Institute, San German, Puerto Rico. *Trichoptera.*
'27. PALMER, MIRIAM A., 621 S. Howes St., Fort Collins, Colo. (F. '37). *Aphiidae.*
'27. PARK, ORLANDO, Dept. Zool., Northwestern Univ., Evanston, Ill. (F. '40). *Pselaphidae.*
'39. Parker, Barbara M., 437 Hibbard Rd., Wilmette, Ill.
'25. PARKER, H. L., South American Parasite Lab., Blanca del Tabare, 2950, Montevideo, Uruguay. (F. '40). *Parasitic Hymenoptera.*
'37. Parker, J. R., Bureau of Ent. & Pl. Quar., Bozeman, Montana. *Orthoptera.*
'24. Parker, R. L., Dept. Ent., K. S. C., Manhattan, Kansas. *Apiculture.*
'18. Parks, T. H., Dept. Ent., Ohio St. Univ., Columbus 10, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Texas. *Diptera.*
'43. Parr, Thaddeus, Box 156, Bexley Station, Columbus 9, Ohio.
Ch. PARROTT, P. J., Agri. Exp. Sta., Geneva, N. Y. (F. '14).
'12. PARSHLEY, H. M., Dept. Zool., Smith College, Northampton, Mass. (F. '43). *Heteroptera.*
'32. Parsons, Carl T., 205 West 57th St., New York, N. Y.
'34. Parton, Herbert L., Div. of Ent., Univ. Farm, St. Paul, Minn. *Greenhouse Insects.*
'32. Passos, Cyril F. dos, Washington Corners, Mendham, N. J. *Lepidoptera.*
Ch. *PATCH, EDITH M., P. O. Box 150, Orono, Maine. (F. '14). *Aphididae.*
'35. Paulian, Renaud, Laboratoire d'Entomologie, Museum d'Histoire Naturelle, 45 bis Rue de Buffon, Paris V, France. *Scarabaeidae, Corylophidae.*
'35. Paullus, Harold J., DeSoto, Missouri.
'23. *PAYNE, NELLIE M., care of American Cyanamid Co., Boston Post Road, Stamford, Conn. (F. '40). *Physiology.*
'20. PEAIRS, L. M., Morgantown, West Va. (F. '40).
'34. Pechuman, La Verne L., 7 Davison Road, Lockport, N. Y. *Tabanidae.*
'40. Pederson, Lt. Calvin E., N. A. T. B. Medical Office, Ft. Pierce, Fla.
'37. Pelton, John Z., 205 First Ave., Waverly, Ohio. *Aquatic Insects.*
'35. Penner, Lawrence R., Dept. Zoology, University of Connecticut, Storrs, Conn. *Araeopidae.*
'30. Pepper, Bailey B., Dept. Ent., Agri. Exp. Sta., New Brunswick, N. J. *Biological Control.*
'32. Pepper, James Hubert, Mont. State College, Bozeman, Mont. *Insecticides.*
'29. Peters, Harold T., Div. of Ent., University Farm, St. Paul, Minn. *Siphonaptera.*

'39. Peterson, Allan G., St. Board of Health, Jackson 113, Miss. *Potato Insects.*
'11. PETERSON, ALVAH, Dept. Ent., Ohio St. Univ., Columbus 10, Ohio. (F. '28). *Biological Control.*
'37. Peterson, Lloyd O. T., Indian Head, Saskatchewan, Canada. *Forest Entomology.*
'39. Petrakis, Manuel M., Rm. 128, Natural Resources Bldg., Univ. of Ill., Urbana, Ill.
'40. Pettit, Lincoln C., 59 Harrison Ave., Baldwin, Long Island, N. Y. *Dermestidae.*
Ch. PETTIT, R. H., Dept. Ent., Michigan State College, East Lansing, Mich. (F. '39). *Coccidae.*
'07. PETRUNKEVITCH, ALEXANDER, Yale Univ., New Haven, Conn. (F. '37). *Arachnida.*
'43. Pfadt, Robert E., Dept. Ent., Univ. of Wyoming, Laramie, Wyo.
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'12. Phillips, W. J., 718 Cargill Lane, Charlottesville, Va. *Harmolita.*
'37. Phillips, W. Levi, 985 South Third East, Salt Lake City, Utah. *Lepidoptera.*
Ch. PIERCE, W. DWIGHT, Los Angeles County Museum, Exposition Park, Los Angeles 7, Calif. (F. '30). *Rhynchophora.*
'41. Platt, Fred R., Deputy Agri. Commissioner, Court House, Riverside, Calif. *Coccidae; Coleoptera.*
'41. Pletsch, Don, Dept. of Entomology, Montana State College, Bozeman, Mont. *Psyllidae, Myrmeleonidae.*
'28. Plummer, C. C., Apartado Num. 3, Colonia Anahuac, Mexico, D. F., Mexico. *Membracidae.*
'18. POOS, FRED W., Beltsville Research Center, Beltsville, Md. (F. '43).
'23. Porter, B. A., Bureau Entomology & Pl. Q., Washington, D. C. *Fruit Insects.*
'43. Porter, John E., Asst. Sanitarian (R), U. S. Public Health Service, Malaria Control in War Areas, Foreign Quarantine Service, 309 U. S. Court House, Fort Worth 2, Texas.
'26. Potts, Samuel F., 56 Hillhouse Ave., New Haven, Conn. *Toxicology, Physiology.*
'36. *Pratt, Harry D., U. S. Public Health Service, District No. 6, San Juan, Puerto Rico. *Ichneumonidae.*
'16. Price, W. A., Univ. Ky., Lexington, Ky. *Economic Entomology.*
'32. *PRITCHARD, A. EARL, 2307 N. W. 19th, Oklahoma City 7, Okla. (F. '43). *Asilidae, Itonididae.*
'40. Pritchett, John C., 22 Federal Office Bldg., Seattle 33, Wash.
'28. PROCTER, WM., Bar Harbor, Maine. (F. '40). *Insects of Mt. Desert Region.*
'33. Putman, W. L., Dom. Ent. Lab., Vineland Sta., Ontario, Can. *Chrysopidae.*

Q

'36. Quarterman, Kenneth D., Box 989, Gulfport, Miss. *Cimicidae.*

R

'42. Ramsay, Maynard J., 2919 Curtis St., Elmhurst, N. Y.
'43. Rapp, William F., Jr., N. J. Agri. Exp. Station, New Brunswick, N. J.
'14. RAU, PHIL, 549 E. Argonne Drive 22, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'42. Reade, Ritchard, British Military Hospital, Kingston, Jamaica, B. W. I.
'23. READIO, PHILIP A., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '37). *Reduviidae.*
'23. Reed, Lt. W. D., Office of the Chief Engineer, New War Bldg., Rm. 6007, Washington, D. C. *Tobacco Insects.*
'30. Rees, Don M., Univ. Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Jos. A., 415 Federal Bldg., Buffalo, N. Y. *Chrysomelidae, Fulgoridae.*
Ch. REHN, J. A. G., Acad. Nat. Science, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'43. Remington, Charles L., 5570 Etzel Ave., St. Louis, Mo.
'34. Rice, Paul L., Dept. of Entomology, Agri. Exp. Sta., Newark, Delaware. *Chalcidoidea.*

'30. RICHARDS, A. GLENN, JR., Zoological Laboratories, Univ. of Penn., 38th St. and Woodland Ave., Philadelphia 4, Pa. (F. '38). *Noctuidae.*
'14. RICHARDSON, CHAS. H., Dept. Ent., Ia. St. Coll., Ames, Ia. (F. '31). *Physiology.*
'29. RICHARDSON, LT. H. H., Port Surgeon's Office, New York Port of Embarkation, Brooklyn, N. Y. (F. '41). *Physiology.*
'28. Richmond, Major Edward A., Tech. Div. C. W. S., Camp Detrick, Md. *Hydrophilidae.*
'39. Riedel, F. Atherton, Morehead State Teachers College, Morehead, Ky.
'43. Rieder, Robert E., Ext. Ent. & Plant Pathologist, Oregon State College, Corvallis, Oregon.
'39. Reigel, Capt. Garland T., 2418 So. Scoville Ave., Berwyn, Ill. *Braconidae.*
'22. Ries, Donald T., Starved Rock State Park, Utica, Ill. *Cephidae, Siricidae.*
'40. Riherd, Lt. (jg) Paul T., Genl. Del., Stephenville, Texas. *Culicidae.*
'29. Riley, Merrill K., Box 38, Kaneohe, T. H. *Coccidae.*
Ch. RILEY, WM. A., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '14). *Parasitology.*
'39. Rings, 2nd Lt. Roy W., 1879 Unit, 8th Service C., Camp Livingston, La. *Cerambycidae.*
'33. Ritcher, Paul O., Agr. Exp. Station, Lexington, Ky. *Phyllophaga.*
'36. Ritchie, 1st Lt. C. L., Post Surgeon's Office, Fort Mason, Calif. *Coccidae, Lepidopterous Larvae.*
'25. Rivnay, Ezekiel, Agri. Exp. Sta., Rehoboth, Palestine. *Thysanoptera.*
'39. Roark, R. C., Bur. Ent. & P. Q., U. S. D. A., Washington, D. C. *Insecticides.*
'40. Roberts, H. Radclyffe, Villa Nova, Pa. *Acrididae.*
'31. Roberts, J. Harvey, Box 8729, University, La. *Trichoptera.*
'28. Roberts, R. A., 1104 S. Runnels St., Big Spring, Texas. *Mantidae.*
'43. Roberts, Reed S., 346 W. First No., Logan, Utah.
'15. Robinson, J. M., Box 671, Auburn, Alabama.
'26. ROBINSON, WM., Burnt Mills Hills, Silver Spring, Maryland. (F. '39). *Physiology.*
'41. Rockstein, S/Sgt. Morris, 2nd Weather Squadron, Lockbourne AAB, Columbus 17, Ohio.
'13. Rockwood, L. P., Forest Grove, Oregon. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. Colo. Museum, Boulder, Colo. *Nomada.*
'15. ROGERS, J. SPEED, Box 2666 Univ. Sta., Gainesville, Fla. (F. '43). *Tipulidae.*
'41. *Rogoff, Ensign William M., H-V(S), USNR, Sanitation Department, Station Hosp., Camp Peary, Va.
'27. ROHWER, S. A., Bur. Ent. & Pl. Q., Washington, D. C. (F. '29). *Hymenoptera.*
'25. Rosewall, O. W., Box 8729, Dept. Ent., Louisiana State Univ., Baton Rouge, La *Coleoptera, Pentatomidae.*
'39. Ross, Lt. Edward S., Dept. Ent., Calif. Acad. Science, Golden Gate Park, San Francisco, Calif. *Histeridae, Embioptera.*
'31. ROSS, HERBERT H., St. Nat. Hist. Surv., Urbana, Ill. (F. '37). *Tenthredinoidea.*
'12. Ross, Wm. A., Vineland Station, Ontario, Canada. *Aphididae.*
'40. Roth, Louis M., 351 East 45th St., Brooklyn 3, N. Y.
'36. Rozeboom, Lloyd Eugene, School of Hygiene and Public Health, 615 N. Wolf St., Baltimore, Md. *Culicidae.*
'14. Ruckes, Herbert, 167–11 33rd Ave., Flushing, L. I., New York. *Pentatomidae.*
'39. Rude, Clifford S., Box 96, Menard, Texas. *Ixodidae.*
Ch. RUGGLES, A. G., University Farm, St. Paul, Minn. (F. '35).
'42. Ryan, George S., care of C. H. Elliott, Angola, Indiana.

S

'33. *SABROSKY, CURTIS W., Dept. of Ent., Mich. State Coll., East Lansing, Mich. (F. '41). *Chloropidae.*
'41. Sailer, Reece I., Division of Insects, U. S. National Mus., Washington, D. C. *Hemiptera.*
'38. Sailsbury, Murl B., 824 Gaffield Place, Evanston, Ill. *Chrysomelid larvae.*
'29. Sakimura, Kay, Pineapple Research Inst., Honolulu 2, Hawaii. *Thysanoptera.*

'37. Sampson, William W., 156 So. 14th St., Richmond, Calif. *Aphididae, Aleurodidae.*
'31. SANDERSON, MILTON W., Ill. State Nat. Hist. Survey, Urbana, Ill. (F. '43). *Coleoptera.*
'07. SATTERTHWAIT, A. F., 806 Ohio St., Urbana, Ill. (F. '30). *Calendra.*
'29. Scaramuzza, L. C., Central Baragua, Prov. of Camaguay, Cuba. *Sugar Cane Insects.*
'30. Schaefer, Paul E., Dept. Zool., Univ. of New Hampshire, Durham, N. H. *Morphology.*
'30. Schlosberg, Morris, P. O. Box 606, West Lafayette, Ind. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii. *Ecology.*
'33. Schmidt, Helen D. O'Neil, Box 3166, Honolulu, Hawaii. *Trichoptera.*
'20. Schmieder, Rudolf G., Zool. Lab., Univ. Pa., Philadelphia, Pa.
'32. SCHMITT, JOHN B., Dept. Ent., N. J. Agri. Exp. Sta., New Brunswick, N. J. (F. '43). *Morphology.*
'34. Schmitt, T. J., Jr., Apt. 16, 1086 Corona St., Denver 3, Colo. *Scolytidae.*
Ch. Schoene, W. J., Agri. Exp. Sta., Blacksburg, Va.
'36. Schoof, Herbert F., M. C. W. A., N. C. State Bd. of Health, Raleigh, N. C. *Chrysomelidae.*
'29. Schroeder, H. O., 623 W. Concord, Orlando, Fla. *Ixodoidea, Argasidae.*
'37. Schroeder, Philip M., 1979 Ashland Ave., St. Paul, Minn. *Forest Insects.*
'40. Schuh, Joe, Dept. Ent., Oregon State College, Corvallis, Oregon. *Odonata.*
'32. Schumaker, George K., 1515 Chew St., Allentown, Pa. *Coleoptera.*
'26. SCHWARDT, H. H., Dept. Ent., Cornell Univ., Ithaca, N. Y. (F. '35). *Tabanidae.*
'26. SCHWARZ, HERBERT F., Am. Mus. Nat. Hist., 77th St. & Cent. Park West, New York, N. Y. (F. '37). *Meliponidae.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Lemna Insects.*
'25. SCULLEN, H. A., Dept. Entomology, Oregon State College, Corvallis, Ore. (F. '40). *Cerceridae.*
'23. Seamans, H. L., Dom. Ent. Lab., Lethbridge, Alberta, Canada. *Muscoidea.*
'41. Sears, Jack W., B. L. 401, Univ. of Texas, Austin, Texas.
'36. Seevers, Charles, Central Y. M. C. A. College, 19 South LaSalle St., Chicago, Ill. *Termitophiles.*
'38. Semans, F. Merrick, North Jackson, Ohio.
'08. SEVERIN, H. C., South Dakota State College, Brookings, S. D. (F. '39). *Orthoptera, Homoptera, Heteroptera.*
'07. SHAFER, GEO. D., 321 Melville Ave., Palo Alto, Calif. (F. '41). *Physiology.*
'18. *SHANNON, R. C., Malaria Bureau, P. O. Box 556, Port of Spain, Trinidad, B. W. I. (F. '34). *Diptera.*
'35. Shaw, Frank R., Fernald Hall, Mass. State College, Amherst, Mass. *Mycetophilidae.*
'29. Shaw, John G., Laboratorio Entomologico, Apt. Num. 3, Colonia Anhuac, D. F., Mexico.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'43. Shenefelt, Roy D., Zool. Dept., Washington State College, Pullman, Wash.
'22. SHEPARD, HAROLD H., 4362 N. Pershing Drive, Arlington, Va. (F. '39). *Hesperiidae.*
'17. Sherman, Franklin, Div. Ent., Clemson College, South Carolina. *Acrididae, Cerambycidae, Cicindelidae.*
'11. SHERMAN, JOHN D., JR., 132 Primrose Ave., Mt. Vernon, N. Y. (F. '39). *Dytiscidae.*
'34. Shields, Lt. S. E., Grand River, Iowa. *Culicoides.*
'35. *Shockley, Wilfred, 1180 Sherman St., Denver 3, Colo. *Cerambycidae, Decticinae.*
'28. Shropshire, Leslie H., California Packing Corp., Rochelle, Ill. *Economic Entomology.*
Ch. SHULL, A. FRANKLIN, 431 Highland Rd., Ann Arbor, Mich. (F. '39). *Aphididae.*
'43. Siegel, Irving, 657 Crotona Park N., New York 57, New York.
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myrizapoda.*

'32. Silvey, J. K. Gwynn, Dept. of Biology, North Texas State Teachers' College, Denton, Texas. *Coleoptera.*
'35. Simizu, Tunehisa, Imp. Pl. Quar. Serv., Nagoya Custom House, Nagoya, Japan. *Bruchidae, Diptera.*
'42. Simmonds, Frederick J., Imperial Parasite Service, Belleville, Ontario, Canada.
'29. Simmons, Perez, 712 Elizabeth St., Fresno 3, Calif. *Dried Fruit Insects.*
'30. Simmons, S. W., Box 547, U. S. Pub. Health Service, Carter Mem. Lab., Savannah, Ga. *Medical Entomology.*
'39. Simonds, Wm. E., Agricultural Bldg., Embarcadero and Mission, San Francisco, Calif. *Elateridae.*
'30. *Simpson, Geddes W., Holmes Hall, Orono, Me. *Insects and Plant Diseases.*
'38. Singleton, J. M., 209 River St., Hoboken, N. J. *Quarantines.*
'43. Slifer, Eleanor H., Dept. Zool., Univ. of Iowa, Iowa City, Iowa.
'32. Smith, Carroll N., P. O. Box 78, Savannah, Ga. *Ixodidae.*
'32. Smith, Chas. E., Agricultural Center, University, La. *Truck Crop Insects.*
'35. Smith, Clyde F., Dept. of Entomology, Univ. of North Carolina, Raleigh, N. C. *Aphididae.*
'27. SMITH, FLOYD F., Research Center, Beltsville, Maryland. (F. '43).
'35. Smith, Frank K., 2228 Elizabeth St., Pueblo, Colo. *Aquatic Coleoptera.*
'28. Smith, Herbert D., 209 River St., Hoboken, N. J. *Ichneumonidae.*
'35. Smith, Howard W., Rear 186 West Woodruff Ave., Columbus, Ohio.
'37. Smith, Marion E., 103 Broadway, Ocean Grove, N. J. *Arctiidae.*
'19. SMITH, MARION R., Rm. 377, U. S. National Museum, Washington, D. C. (F. '38). *Formicidae.*
'39. Smith, Myron W., 632 Dermon Bldg., Memphis, Tenn. *Curculionidae.*
'36. Smith, Ralph H., Univ. of Calif., 405 Hilgard Ave., Los Angeles, Calif. *Hemiptera.*
'42. Smith, Ray F., 112 Agri. Hall, Univ. of California, Berkeley, Calif.
'14. SMITH, ROGER C., 2009 Twentieth Road North, Arlington, Va. (F. '31). *Neuroptera.*
'38. Smith, Septima C., Box 1446, University, Alabama. *Odonata.*
'18. Snapp, Oliver I., Box 527, Fort Valley, Georgia. *Rhynchophora.*
'39. Snipes, Benjamin T., Office of State Entomologist, State Dept. of Agri., Powell, Wyo. *Siphonaptera.*
'24. SNODGRASS, R. E., 3706 Thirteenth St., N. W., Washington, D. C. (F. '27). *Morphology.*
'36. Snyder, Fred M., 2015 Jefferson St., Madison 5, Wisconsin. *Muscoidea.*
'38. Sommerman, Kathryn M., Nat. Hist. Survey, 227 Nat. Resources Bldg., Urbana, Ill. *Corrodentia.*
'26. Sorenson, Chas. J., Agri. Exp. Sta., Logan, Utah. *Miridae.*
'43. Sparks, Sue D., see Mrs. W. M. Lewis.
'14. *Spencer, G. J., Univ. Brit. Col., Vancouver, Brit. Col., Canada. *Trypetidae.*
'19. SPENCER, LT. COL. HERBERT, Monticello Hotel Apts., A-3, Charlottesville, Va. (F. '37). *Hymenoptera.*
Ch. SPOONER, CHAS. S., 1436 Seventh St., Charleston, Ill. (F. '43). *Fulgoridae.*
'29. Spruijt, F. J., 3248 "O" St., N. W., Washington, 7, D. C. *Formicidae.*
'39. Stafford, Eugene M., Rt. 8, Box 721, Fresno, Calif. *Vegetable Insects.*
'10. STAFFORD, E. W., State College, Miss. (F. '43). *Mallophaga.*
'38. Stains, George S., care of Geo. F. Knowlton, Dept. Ent., Utah Agri. College, Logan, Utah. *Conopidae, Simuliidae.*
'30. Stanford, J. S., Agri. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agri. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'35. Stehr, William C., Dept. of Biology, Ohio Univ., Athens, Ohio. *Coccinellidae, Carabidae.*
'38. Steiner, Harold M., Box 123, Arendtsville, Pa. *Fruit Insects.*
'27. Steiner, L. F., 1237 Washington Ave., Vincennes, Indiana. *Fruit Insects.*
'29. Steinweden, John B., Bur. Nursery Service, State Dept. Agriculture, Sacramento, Calif. *Coccidae, Thysanoptera.*
'31. STEWART, M. A., Div. of Ent. & Parasitology, 112 Agri. Hall, Univ. of Calif., Berkeley 4, Calif. (F. '41). *Siphonaptera.*
'15. Stiles, Chas. F., Box 29, Stillwater, Okla.
'38. Stitt, Loyd L., Dept. Zool. & Ent., Iowa State Coll., Ames, Iowa. *Miridae.*

'27. STONE, ALAN, Bureau Entomology and Plant Quar., Washington 25, D. C. (F. '40). *Simuliidae, Tabanidae.*
'36. Stone, Philip C., Dept. of Entomology, Univ. of Missouri, Columbia, Mo. *Ixodidae.*
'28. Stone, Wm. E., Laboratorio Entomologico, Apartado Num. 3, Colonia Anahuac, D. F., Mexico.
'42. Strandtmann, R. W., Dept. Preventive Medicine, Med. Branch, Univ. of Tex. Galveston, Texas.
'12. Strickland, E. H., Main Library, Univ. of Alberta, Edmonton, Alberta, Canada. *Elateridae.*
'25. Strohecker, H. F., Dept. Biology, Kenyon College, Gambier, Ohio.
'34. Strom, Lawrence G., 604 A. South 28th St., Milwaukee, Wis. *Aphiidae.*
'31. Summerour, A. R., Box 173, Lucedale, Miss.
'23. SWEETMAN, HARVEY L., State College, Amherst, Mass. (F. '43). *Ecology.*
'20. SWEZEY, OTTO H., 2044 Lanihuli Drive, Honolulu 5, Hawaii. (F. '30). *Delphacodae.*

T

'37. Talbot, Mary, Lindenwood College, St. Charles, Missouri. *Formicidae.*
'36. Tanner, M. C., 2902 Jackson Ave., Ogden, Utah. *Plecoptera.*
'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
Ch. Tanquary, M. C., Univ. Farm, St. Paul, Minn. *Apiculture.*
'40. Tarshis, Irvin, 1032 N. W. 14th Ave., Portland 9, Oregon.
'31. Tate, H. D., Dept. of Ent., College of Agriculture, Lincoln, Neb. *Ixodidae.*
'36. *Tauber, Oscar E., Zool. Dept., Iowa State College, Ames, Iowa. *Physiology.*
'22. Taylor, Leland H., Dept. Botany & Zool., W. Va. Univ., Morgantown, W. Va. *Bees, Wasps.*
'29. Taylor, R. L., 627 Powell St., Williamsburg, Va. *Parasitic Hymenoptera.*
'34. *Telford, Horace S., Research Labs., Dr. Hess & Clark, Inc., Ashland, Ohio. *Syrphidae.*
'40. Thatcher, Capt. Theodore O., care of J. Karl Wood, River Heights, Logan, Utah. *Scolytidae, Buprestidae, Cerambycidae.*
'21. Thomas, Chas. A., 120 S. Broad St., Kennett Square, Chester County, Pa. *Elateridae, Scarabaeidae.*
'32. Thomas, Edward S., Ohio State Museum, Ohio St. Univ., Columbus 10, Ohio. *Orthoptera.*
'38. Thomas, Henry D., North Park College, Foster & Kedzie, Chicago 25, Ill.
'15. Thomas, F. L., College Station, Texas. *Cotton Insects.*
'39. Thompson, W. L., Box 1074, Lake Alfred, Fla. *Citrus Insects.*
'10. THOMPSON, W. R., 228 Dundas St., Belleville, Ontario, Canada. (F. '27). *Tachinidae.*
'22. Tietz, Harrison M., Dept. Zool., Pa. St. Coll., State College, Pa. *Noctuidae.*
'11. TIMBERLAKE, P. H., Citrus Exp. Sta., Riverside, Calif. (F. '38). *Encyrtidae.*
'23. Tissot, A. N., Agr. Exp. Station, Gainesville, Fla. *Aphididae.*
'26. Todd, F. E., care of Bee Culture, Beltsville, Md. *Apiculture.*
'33. Tongyai, M. R. Chakratong, Dept. of Agriculture, Bangkok, Thailand. *Buprestidae.*
'29. Tosawa, Nobuyoshi, Kotoen, near Nishinomiya, Hyogo-ken, Japan. *Hymenoptera.*
'33. TOWNES, HENRY K., JR., 24 Lincoln Ave., Takoma Park, Md. (F. '43). *Ichneumonidae, Chironomus.*
'28. Townsend, Lee H., Dept. Ent., Univ. of Kentucky, Lexington, Ky. *Neuroptera.*
'36. Trager, Lt. Wm., Camp Hdq., 6th Army Training Center, A. P. O. 926, care of Postmaster, San Francisco, Calif. *Insect Nutrition.*
'39. Traub, Lt. Robert, care of Dept. Ent., Univ. of Ill., Urbana, Ill. *Siphonaptera.*
'30. TRAVER, (MISS) JAY R., Fernald Hall, Mass. State College, Amherst, Mass. (F. '35). *Ephemeridae.*
'30. Travis, Bernard V., Box 3391, Orlando, Fla. *Culicidae.*
'39. Trembley, Helen L., National Institute of Health, Bethesda, Md.

'34. Trippel, A. W., Indiana Dept. of Conservation, Box 408, Auburn, Indiana. *Chrysomelidae.*
'38. Tuck, Lt. Joseph B., 1110 Kearney St., Manhattan, Kansas. *Orthoptera.*
'08. Turner, Wm. F., 310 Woodward Ave., Chattanooga, Tenn.
'29. *TUTHILL, L. D., Dept. of Ent., Ia. St. College, Ames, Ia. (F. '43). *Psyllidae, Fulgoridae.*

U

'39. Uchida, T., Entomological Institute, Hokkaido Imp. Univ., Sapporo, Japan. *Ichneumonidae.*
'20. Uichanco, L. B., Agri. College, Laguna, P. Is. *Hemiptera.*
'32. USINGER, ROBERT L., 605 Volunteer Bldg., Atlanta, Ga. (F. '41). *Heteroptera, excepi Corixidae.*

V

'22. Vance, Arlo M., Box 606, West Lafayette, Ind. *Ecology.*
Ch. Van Dine, D. L., 805 Crescent Drive, Alexandria, Va. *Fruit Insects.*
Ch. VAN DYKE, E. C., Dept. of Entomology, California Acad. Sci., Golden Gate Park, San Francisco, Calif. (F. '17). *Coleoptera.*
'39. Vazquez, Leonila (Miss), Instituto de Biologia, Casa del Lago, Chapultepec D. F., Mexico. *Psychidae.*
'42. Velasco, Vicente, Carrera 9a-No. 4-68, Coli, Colombia.
'43. Venard, Carl E., Dept. Zool. & Ent., Ohio State Univ., Columbus 10, Ohio.
'37. Viado, Getulio B., Agricultural College, Laguna, P. I. *Toxicology.*
'40. Vogt, George B., Frederick Rd. (opposite Ilchester Rd.), Catonsville, Md. *Coleoptera, Hemiptera.*

W

'15. WADE, J. S., Bur. Ent. & Pl. Quar., Washington, D. C. (F. '37). *Coleoptera.*
'21. WADLEY, F. M., 3215 N. Albemarle, Arlington, Va. (F. '39). *Aphididae.*
'18. Wainwright, C. J., 172 Hamstead Rd., Handsworth, Birmingham, England. *Tachinidae.*
'22. Walkden, Herbert H., Bur. Ent. & Pl. Quar., 201 Post Office Bldg., Hutchinson, Kans. *Noctuidae.*
'10. WALKER, E. M., Dept. Biol., Univ. Toronto 5, Ontario, Canada. (F. '14). *Odonata, Orthoptera.*
'30. Walker, Harry G., Va. Truck Exp. Sta., P. O. Box 267, Norfolk, Va. *Economic Entomology.*
'38. Wallace, George E., Dept. Ent., Carnegie Museum, Pittsburgh, Pa. *Chalcididae.*
'23. Wallace, Hugh E., 210 Santa Rita, Modesto, Calif.
'32. WALLEY, G. STUART, Ent. Branch, Ottawa, Ontario, Canada. (F. '41). *Hymenoptera, Hemiptera.*
'37. Walter, E. V., Box 495, Lafayette, Indiana. *Economic Entomology.*
'17. WALTON, WM. R., Bur. Ent. & Pl. Quar., Washington, D. C. (F. '37).
'36. Wardle, Robert A., Dept. of Zool., Univ. of Manitoba, Winnipeg, Manitoba, Canada.
'42. Watkins, Thomas C., Comstock Hall, Cornell Univ., Ithaca, N. Y.
'13. WATSON, J. R., Agri. Exp. Sta., Univ. Fla., Gainesville, Fla. (F. '39). *Thysanoptera.*
'25. Watson, S. A., Wilmington College, Wilmington, Ohio. *Miridae, Hemiptera.*
'16. Webber, Ray T., 8 Whippany Road, Morristown, N. J. *Tachinidae.*
'34. Weber, Neal A., Dept. of Biology, University Station, Grand Forks, N. D. *Formicidae.*
Ch. WEBSTER, R. L., Agri. Exp. Sta., Pullman, Washington. (F. '32).
Ch. WEED, CLARENCE M., 854 Andover St., Lowell, Mass. (F. '24).
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Y

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Z

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Total Membership, 934. Fellows, 250. Honorary Fellows, 11.

It is interesting to note that there are 71 Charter Members and 44 Life Members.

INDEX TO VOLUME XXXVII

All new names are printed in *italics*.

Abitagus, 315.
Acridinae, 54.
Acropyga roger, the neotropical coccid-tending ants of the genus, 89.
Acropyga (Rhizomyrma), 92.
  berwicki, 107.
  borgmeiri, 111.
  bruchi, 103.
  columbica, 94.
  decedens, 92.
  donisthorpei, 118.
  dubitata, 98.
  exsanguis, 96.
  fuhrmanni, 96.
  göldii, 93.
  guianensis, 120.
  kathrynae, 114.
  marshalli, 101.
  mesonotalis, 111.
  oko, 119.
  pachycera, 95.
  paludis, 121.
  panamensis, 113.
  paramaribensis, 103.
  parvidens, 100.
  pickeli, 102.
  quadriceps, 113.
  robae, 110.
  rutgersi, 104.
  smithi, 95.
  tridentata, 94.
  trinitatis, 117.
  urichi, 115.
  wheeleri, 101.
Aedes, 379.
  atlanticus, 379.
  canadensis, 379.
  cantator, 379.
  dupreei, 379.
  sollicitans, 379.
  taeniorhynchus, 379.
  triseriatus, 379.
  vexans, 379.
Aeshna rufipennis, The female of, 372.
Agrilus with descriptions of two new species, Notes on, 75.
Agrilus *amelanchieri*, 80.
  baboquivari, 78.
  barberi, 83.
  cavifrons, 75.
  cliftoni, 78.
  coeruleus, 80.
  costipennis, 78.
  fuscipennis, 78.
  lautuellus, 80.
  mimosae, 82.
  neoprosopidus, 83.
  obolinus, 80.
  obsoletoguttatus, 80.
  palmerleei, 76.
  pseudofallax, 83.
  snowi, 78.
  ventralis, 80.
  ornatulus, 80.
Alexander, Charles P. Article by, 298.
Amapsocus amabilis (Walsh), Bionomics of, 359.
Amphalius necopinus, 207.
Amphipsylla sibirica pollionis, 207.
Anopheles quadrimaculatus Say, with a comparison of the developmental power of constant and variable temperatures in insect metabolism, The temperature relations of the immature stages of the malarial mosquito, 1.
Anopheles, 379.
  barberi, 379.
  bradleyi, 379.
  crucians, 379.
  punctipennis, 379.
  quadrimaculatus, 379.
Anthropomorphism in insect psychology, 201.
Ants of the Chicago Region, The, 447.
Ants of the genus Acropyga roger, the neotropical coccid-tending, 89.
Aphaenogaster, 465.
Aphonus *brevicruris*, 36.
Arctopsylla ursi, 207.
Ataenius *linelli*, 28.
  saxatilis, 29.
Atarba, 316.
Atarba (Atarba), 316.
  procericornis, 316.
Atrichopogon levis (Coquillett), Observations on the early stages and life history of the grass punky, 37.
Aureata group, 434.

Babers, Frank H. (with Mayer). Article by, 214.
Boesel, M. W. (with Snyder). Article by, 37.

Book Notices, Authors:
  Antunes, Waldemar Sa, 200.
  Blackwelder, Richard E., 220, 419.
  Carpenter, F. M., 364.
  Carriker, M. A., Jr., 413.
  Coggesshall, Lowell T., 358.

BOOK NOTICES, AUTHORS—(*Continued*)
Comstock, William P., 192.
Costa-Lima, A. da, 388.
Danielli, James Frederic, 83.
Davson, Hugh, 83.
DeLong, Dwight M., 322.
Deming, W. Edwards, 160.
Dice, Lee R., 440.
Essig, E. O., 324.
Fattig, P. W., 323.
Good, Newell E., 375.
Gray, H. F., 351.
Griswold, Grace H., 413.
Heilbrunn, L. V., 88.
Hermes, William B., 351.
Hoffman, William E., 324.
Hoskins, W. M., 324.
Huntington, E. Irving, 192, 408.
Jellison, William. 375.
Komp, W. H. W., 387.
Lima, Servulo, 200.
Lumley, George F., 123.
Mackie, Thomas T., 358.
Matheson, Robert, 358.
McDunnough, J., 324.
Ross, Edward S., 371.
Ross, H. H., 371, 392.
Roth, Louis M., 388.
Seevers, Charles H., 297.
Solomon, M. E., 69.
Soper, Fred L., 200, 206.
Stoll, Norman R., 358.
Stunkard, Horace W., 358.
Taylor, Frank H., 123.
Wenzel, Rupert L., 375.
Wilson, D. Bruce, 200, 206.

BOOK NOTICES, BOOKS:
Anopheles Gambiae in Brazil 1930-1940, by Fred L. Soper and D. Bruce Wilson, 206.
Anopheles of the Southeastern United States, by Male Genitalia, A Key to the, by Louis M. Roth, 388.
Anopheline Mosquitoes of the Caribbean Region, The, by W. H. W. Komp, 387.
Anti-aedes Aegypti Measures in Brazil, The Organization of Permanent Nation-Wide, by Fred L. Soper, D. Bruce Wilson, Servulo Lima, and Waldemar Sa Antunes, 200.
Biotic Provinces of North America, The, by Lee R. Dice, 440.
Caddis Flies, or Trichoptera, of Illinois, The, by Herbert H. Ross, 392.
Carboniferous Insects from the Vicinity of Mazon Creek, Illinois, by F. M. Carpenter, 364.
Coleopterous Insects of Mexico, Central America, the West Indies and South America, Checklist of the, by Richard E. Blackwelder. Part I, 220, Part II, 419.
Culicidae of the Australian Region, A Checklist of the, by Frank H. Taylor, 123.
Dengue, Part I. Medical, by George F. Lumley, 123. Part II, Entomological, by Frank H. Taylor, 123.
Embioptera, or Web-Spinners, of the New World, A Revision of the, by Edward S. Ross, 371.
Gyponinae (Homoptera–Cicadellidae) Exclusive of Xerophloea, A Monographic Study of the North American Species of the Subfamily, by Dwight M. DeLong, 322.
Histerid Beetles, On the Classification of the, by Rupert L. Wenzel, 375.
Insectos Do Brasil, by A. da Costa-Lima, 388.
Insects, How to Collect and Preserve, by H. H. Ross, 371.
Insects and Other Pests Attacking Agricultural Crops, by E. O. Essig and W. M. Hoskins, 324.
Insects of Porto Rico and the Virgin Islands, Rhopalocera or Butterflies, by William Phillips Comstock, 408.
Lycaenidae of the Antilles (Lepidoptera, Rhopalocera), by William P. Comstock and E. Irving Huntington, 192.
Mosquito Control, by William B. Hermes and H. F. Gray, 351.
Mosquito Intermediary Hosts of Diseases in Australia and New Guinea, by Frank H. Taylor, 123.
Neotropical Mallophaga (III). Tinamidae No. 2, Studies in, by M. A. Carriker, Jr., 413.
Parasitic Diseases and American Participation in the War, by Horace W. Stunkard, Lowell T. Coggesshall, Thomas T. Mackie, Robert Matheson, and Norman R. Stoll, 358.
Permeability of Natural Membranes, The, by Hugh Davson and James Frederic Danielli, with a foreword by E. Newton Harvey, 83.
Phalaenid Subfamily Plusiinae (Lepidoptera), Revision of the North American Genera of the, by J. McDunnough, 324.
Phyllophaga or May Beetles of Georgia, The, by P. W. Fattig, 323.
Physiology, An Outline of General, by L. V. Heilbrunn, 88.
Reduviidae of China, Catalogue of the, by William E. Hoffman, 324.

Book Notices, Books—(*Continued*)
Siphonaptera of North America, Index to the Literature of, by William Jellison and Newell E. Good, 375.
Staphylinidae, Amblyopininae, A New Subfamily of Beetles Parasitic on Mammals, by Charles H. Seevers, 297.
Statistical Adjustment of Data, by W. Edwards Deming, 160.
Tyroglyphid Mites in Stored Products. I. A Survey of Published Information, by M. E. Solomon, 69.
Webbing Clothes Moth (Tineola Bisselliella Hum.), Studies on the Biology of the, by Grace H. Griswold, 413.

Borror, Donald J. Article by, 393.
Brachymyrmes, 469.
Breviura group, 423.
Brown, John H. Article by, 207.
Brown, F. Martin. Article by, 255.
Bugbee, Robert E. Article by, 420.

Camponotus, 477.
Camponotus ants, nutritional requirements of, 401.
Cartwright, O. L. Article by, 28.
Catallagia borealis, 207.
charlottensis, 208.
decipiens, 208.
Cediopsylla inaequalis inaequalis, 208.
Ceratophyllus garei, 208.
niger, 208.
Chlorion (amobia) pennsylvanicum L., The nesting habits of the wasp, 439.
Cicadellidae, Nomenclatorial notes on, 123.
Comparative study of the appendages of the eighth and ninth abdominal segments of insects, A, 336.
Comperiella bifasciata, an endoparasite of Diaspine coccids, Observations on, 365.
Conocephalinae, 60.
Coriphorinae, 60.
Corrections (omissions and errors), 481.
Corrodopsylla curvata curvata, 208.
Crane-flies from South America, part XI, New species of, 298.
Crematogaster, 461.
Ctenolimnophila (Abitagua), 315.
longifusa, 315.
Ctenocephalides canis, 208.
felis felis, 208.
pseudagyrtes, 208.
terribilis, 208.
Culex apicalis, 379.
erraticus, 379.
peccator, 379.
quinquefasciatus, 379.
restuans, 379.
salinarius, 379.
Culex (Melanoconium) atratus theobald in Florida; a new continental North American record, with notes on the other Melanoconions of the Southeastern United States, 84.
Curculionidae, Douttia, a new genus of New Hebridean, 193.
Cyrtacanthacrinae, 56.

Dactylopsylla ignota albertensis, 208.
Dasymutilla permista Mickel to Dasymutilla quadriguttata (Say) and behavior notes on the species, The relationship of, 198.
Decticinae, 60.
DeBach, Paul. Article by, 70.
DeLong, Dwight M. Article by, 68.
Delotelis telegoni, 208.
Dolichoderinae, 467.
Dolichoderus, 467.
Dorsey, C. K. Article by, 376.
Dorymyrmex, 468.
Douttia, a new genus of New Hebridean Curculionidae, 193.
Douttia bicolor, 194.

Ecuadorian butterflies. IV. The genus penrosada, New, Notes on, 255.
Environmental contamination by an insect parasite and the effect on host selection, 70.
Epiphragma, 313.
Epiphragma (Epiphragma), 313.
phaeoxantha, 313.
Epitedia inopina, 208.
wenmanni, 209.
Erythrodiplax maculosa, 389.
Erythrodiplax maculosa (Hagen), Additional notes on, 393.
Erythrodiplax maculosa (Hagen), Description of the male of, 389.
Eucanthus *alutaceus*, 30.
lazarus, 30.
Eumasticidae (Orthoptera), Ileal caeca in the, 441.
Eurytoma from Mexico, Eleven new species of, 420.
Eurytoma *aureata*, 434.
breviura, 423.
excellens, 433.
imago, 426.
lata, 425.
levidensis, 428.
linearis, 424.
numerosa, 436.
spadix, 429.
subfusca, 432.
tepicensis, 437.
venula, 431.

Flanders, Stanley E. Article by, 365.
Fleas (Siphonaptera) of Alberta, with a list of the known vectors of Sylvatic plague, The, 207.
Formica, 472.
Formicidae, 459.
Formicinae, 469.
Frost, S. W. (with Haber). Article by, 161.

Gnophomyia, 317.
Gnophomyia (Gnophomyia), 317.
coxitalis, 317.
flebilis, 320.
perlata, 320.
teleneura, 318.
Grass Punky, Atrichopogon levis (Coquillett), Observations on the early stages and life history of the, 37.
Gregg, Robert E. Article by, 447.

Haber, V. R. (with Frost). Article by, 161.
Hemocytes are blocked with Chinese ink or nephrocytes are stained with trypan blue, Effect of potassium fluoride and pyrethrum on, Periplaneta americana (L.) after, 414.
Heteroptera, A case of prenatal care in the, 161.
Hoplopsyllus, 209.
Huckett, H. C. Article by, 261.
Huffaker, Carl B. Article by, 1.
Hydrophoria robineau-desvoidy, A revision of the North American species belonging to the genus, 261.
Hydrophoria, 264, 271.
alaskensis, 286.
altilega, 275.
alpina, 272.
ambigua, 296.
borealis, 284.
brunneifrons, 282.
conica, 288.
divisa, 278.
fasciculata, 288.
flavohalterata, 297.
frontata, 274.
galeata, 290.
ignobilis, 295.
implicata, 287.
katmaiensis, 280.
laticornis, 276.
lucidiventris, 286.
nigerrima, 276.
packardi, 297.
polita, 272.
proxima, 279.
ruralis, 291.
seticauda, 292.
uniformis, 294.
verticina, 271.
wierzejskii, 283.
zetterstedti, 292.
Hystrichopsylla gigas dippiei, 209.

Ileal caeca in the Eumastacidae (Orthoptera), 441.
Index to Volume XXXVII, 481.
Iridomyrmes, 468.
Isely, F. B. Article by, 47.
(Ixodidae), biology of Ixodes murus Bishopp and Smith, 221.
Ixodes muris Bishopp and Smith (Ixodidae), Biology of, 221.

Kennedy, Clarence Hamilton. Article by, 372.
Knull, Dorothy J. Article by, 123.
Knull, J. N. Article by, 75.
Kramer, Sol. Article by, 167.

Lasius, 470.
Lawson, Chester A. Article by, 409.
Leptothorax, 466.
Ligyrus *blatchleyi*, 34.
Limonia, 309.
Limonia (Geranomyia), 310.
pastazina, 312.
refuga, 311.
stenophallus, 310.
Limonia (Limonia) *aurigens*, 309.

Madden, A. H. Article by, 145.
Mansonia, 379.
perturbans, 379.
Mayer, Elmer L. (with Babers). Article by, 214.
McGovran, E. R. (with Yeager, Mayer and Munson). Article by, 414.
Megarhinus, 379.
septentrionalis, 379.
Megarthroglossus divisus divisus, 209.
Melanoconions of the Southeastern United States, Culex (Melanoconion) atratus theobald in Florida; a new continental North American record, with notes on the other, 84.
Membership List, v.
Michener, Charles D. Article by, 336.
Monomorium, 466.
Morphology and food specificity in grasshoppers, Correlation between mandibular, 47.
Mosquito survey activities at Camp Peary, Virginia, 376.
Munson, Sam C. (with Yeager). Article by, 396.
Munson, Sam C. (with McGovran, Yeager and Mayer). Article by, 414.

Muscopteryx, 352.
chaetosula, 353.
hiemalis, 355.
hilaris, 355.
hinei, 354.
longiseta, 355.
nitida, 357.
parilis, 356.
Muscopteryx, New North American Tachinidae belonging to the genus, 352.
Myrmecina, 462.
Myrmica, 463.
Myrmicinae, 460.

Nearctopsylla brooksi, 209.
genalis genalis, 209.
Neopsylla inopina, 209.
Nomenclatorial notes on Cicadellidae, 123.

Oblong-winged katydid, Amblycorypha oblongifolia (De Geer), The external morphology of the, 167.
Odontopsyllus multispinosus, 209.
Oedipodinae, 54.
Orchopeas agilis, 212.
caedens, 209.
leucopus, 209.
sexdentatus, 209, 212.
Ornithodoros coriaceus Koch (Argasidae), The life history of the tick, 325.
Oropsylla (Opisocrostis) bruneri, 209.
labis, 210, 212.
tuberculata tuberculata, 210, 212.
Oropsylla (Oropsylla) arctomys, 210.
idahoensis, 210, 212.
rupestris, 210, 212.
Orthopodomyia, 379.
alba, 379.
signifera, 379.
Ozodicera, 299.
piatrix, 299.

Paratrechina, 469.
Parthenogenetic apids, The relation of hind tibiae and sensoria to intermediacy in, 409.
Penrosada, New, Notes on Ecuadorian butterflies. IV. The genus, 255.
Penrosada, 255.
apiculata, 257.
curvilinea, 258.
discontinua, 260.
interrupta, 257.
lanassa, 258.
leaena, 256.
neglecta, 260.
reducta, 260.
Periplaneta americana (L.) after hemocytes are blocked with chinese ink or nephrocytes are stained with trypan blue, Effect of potassium fluoride and pyrethrum on, 414.
Peromyscopsylla hamifer hamifer, 210.
selenis, 210.
Phaneropterinae, 58.
Pheidole, 462.
Phyllophaga *isolita*, 33.
marginalis, 33.
tecta, 32.
yemasseei, 30.
Plummerella (Homoptera, Cicadellidae) from Mexico, A new species of, 68.
Plummerella *lineata*, 68.
Polyergus, 476.
Ponera, 460.
Ponerinae, 459.
Prenatal care in the Heteroptera, A case of, 161.
Prenolepis, 469.
Proceratium, 460.
Prodenia eridania (Cramer), Head-capsule measurements of southern armyworm larvae, 214.
Prodenia eridania (Cram.), Fat inclusions in blood cells of the southern armyworm, 396.
Proceedings of the thirty-eighth annual meeting of the Entomological Society of America, 124.
Pseudophyllinae, 58.
Psorophora, 379.
ciliata, 379.
columbiae, 379.
ferox, 379.
howardii, 379.
Pulex irritans, 210, 212.

Rau, Phil. Articles by, 201, 439.
Rectofrontia fraterna, 210.
Reinhard, H. J. Article by, 352.
Remington, Charles L. Article by, 198.
Romaleinae, 55.
Roth, Louis M. Article by, 235.
Roth, Louis M. (with Young). Article by, 84.

Santos, N. Dias dos. Article by, 389.
Scarabaeidae from United States, New, 28.
Sylvatic plague, The fleas (Siphonapters) of Alberta, with a list of the known vectors, 207.
Siphonaptera, 207.
Slifer, Eleanor H. Article by, 441.
Smith, Carroll N. Articles by, 221, 325.
Smith, Falconer. Article by, 401.
Snyder, E. G. (with Boesel). Article by, 37.
Solenopsis, 461.

Sommerman, Kathryn M. Article by, 359.
Southern armyworm larvae (Prodenia eridania (Cramer), Head-capsule measurements of, 214.
Stenamma, 464.
Stigmatomma, 460.
Strumigenys, 461.
Sylvatic plague, The fleas (Siphonaptera) of Alberta, with a list of the known vectors of, 207.

Tachinidae belonging to the genus Muscopteryx, New North American, 352.
Tamiophilia grandis, 210.
Tanypremna (Tanypremnella), 300.
mediocornis, 300.
Tapinoma, 468.
Tetramorium, 462.
Temperature relations of the immature stages of the malarial mosquito, Anopheles quadrimaculatus Say, with a comparison of the developmental power of constant and variable temperatures in insect metabolism, The, 1.
Theobaldia, 379.
inornata, 379.
melanura, 379.
Thrassis acamantis, 210, 212.
bacchi, 210.
gladiolis gladiolis, 211, 212.
petiolatus, 211, 212.
Tipula, 301.
emerita, 304.
hedymopa, 303.
luterlimbata, 305.
osculata, 301.
Tipula (Nephrotomodes), 306.
cerogama, 306.
palaeogama, 307.
Tobacco hornworm, The external morphology of the adult, 145.
Trentepohlia, 321.
Trentepohlia (Mongoma) *errans*, 321.
Tribolium confusum Duval, Studies on, 235.
Trichopsylla (Trichopsylla) abantis, 211.
asio asio, 211.
atrox, 211.
bitterrootensis, 211.
eumolpi eumolpi, 211, 212.
lucifer, 211.
quirini, 211.
thamba, 211, 212.
vison, 211.
wagneri systalta, 211.

Uranotaenia, 379.
sapphirina, 379.

Weber, Neal A. Article by, 89.

Yeager, J. Franklin (with Munson). Article by, 396.
Yeager, J. Franklin (with McGovran, Mayer and Munson). Article by, 414.
Young, Frank N. (with Roth). Article by, 84.

Zimmerman, Elwood C. Article by, 193.

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CONTENTS OF THIS NUMBER

PAGE

Dos Santos, N. Dias—Description of the Male of *Erythrodiplax maculosa* (Hagen) (Odonata: Libellulidae) 389

Borror, Donald J.—Additional Notes on *Erythrodiplax maculosa* (Hagen) (Odonata: Libellulidae) 393

Munson, Sam C., and Yeager, J. Franklin—Fat Inclusions in Blood Cells of the Southern Armyworm, *Prodenia eridania* (Cram.) 396

Smith, Falconer—Nutritional Requirements of Camponotus Ants 401

Lawson, Chester A.—The Relation of Hind Tibiae and Sensoria to Intermediacy in Parthenogenetic Aphids 409

McGovran, E. R., Yeager, J. Franklin, Mayer, E. L., and Munson, Sam C.—Effect of Potassium Fluoride and Pyrethrum on *Periplaneta americana* (L.) after Hemocytes Are Blocked with Chinese Ink or Nephrocytes are Stained with Trypan Blue 414

Bugbee, Robert E.—Eleven New Species of Eurytoma from Mexico (Eurytomidae: Hymen.). Parts III and IV. Breviura and Aureata Groups 420

Rau, Phil—The Nesting Habits of the Wasp, *Chlorion* (*ammobia*) *pennsylvanicum* L. 439

Slifer, Eleanor H.—Ileal Caeca in the Eumastacidae (Orthoptera) 441

Gregg, Robert E.—The Ants of the Chicago Region 447

Book Notices 392, 408, 413, 419, 440

Corrections (Errors and Omissions) 481

Index to Volume XXXVII 483

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